Knowledge.

With which is incorporated Hardwicke's Science Gossip, and the Illustrated Scientific News.

A Monthly Record of Science.

Conducted by Wilfred Mark Webb, F.L.S., and E. S. Grew, M.A.

SEPTEMBER, 1914.

A WANDERING LICHEN.

(*Parmelia revoluta* var. *concentrica* Cromb.)

By ROBERT PAULSON, F.L.S., and SOMERVILLE HASTINGS, M.S.

THIS plant was first found on Melbury Hill, near Shaftesbury, Dorsetshire, in 1855, by Sir William Trevelyan, and notes respecting it appeared in the *Gardeners' Chronicle* for February 9th and March 15th, 1856, followed by the familiar initials, M. J. B. It is described there as a spherical, unattached lichen, which rolls on the exposed downs, and it was suggested by Trevelyan that certain of the Parmelias were blown off the trees and carried for a considerable distance to the downs by the west or south-west winds, to which the spot, where the specimens were collected, is much exposed; and that there, lodged among the short herbage, they continued to grow, though liable to be rolled about continually by the wind. Crombie endorsed these views, for in a communication to the *Journal of Botany*, in 1872, he writes: "This curious variety occurs on the ground in a free condition as small globular balls. There is no reason to suppose that it is free *ab initio*, but that, after being detached, it assumes this form from accidental circumstances." While at Braemar, in 1872, he saw a peculiar form of *Parmelia omphalodes* Ach. rolled about by the wind on the detritus of Morrone, one of the N. Grampians. He says, in the note already referred to, that it is a state analogous to *Parmelia revoluta* var. *concentrica*, but that the masses are not so spherical. He named it *Parmelia omphalodes* (*form* 2) *sub-concentrica*, and concluded it originated from var. B of *P. omphalodes panniformis* by nodular excrescences of the thallus becoming detached from the rocks on which the lichen grew. Probably it was the sight of this that caused him to give so decided an opinion on the origin of the Melbury specimens. We have not succeeded in finding any recent records of the Melbury plant, nor does it appear in any of the Continental floras that we have consulted.

Specimens of the lichen we are about to describe were first found on the downs near Seaford, in August, 1904, by D. J. Scourfield, who sent it to friends whom he thought might be interested. On that occasion we received a small portion of a specimen, but had no opportunity then of following it up. E. M. Holmes secured some further specimens from Seaford about four years ago, and exhibited some of them at a meeting of the Linnean Society, and made a few comments on its wandering habit.

The writers have recently spent some time near Seaford investigating this plant. On searching the downs between Eastbourne and Seaford no traces of the lichen were found, except over a small area of about eight acres on the Seaford Downs. This area, apparently, presents no peculiar features. It slopes gently towards the west, and is fully exposed to the south-west winds. It is covered by the turf of a chalk down, with occasional patches of stunted gorse. Over most of the area the lichen is freely distributed, as will be seen by Figure 309, which is quite typical of the whole habitat, but it is not found at all amongst the stunted gorse bushes. A number of flints are scattered over the turf,

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and these are perhaps slightly more numerous at this place than on the downs generally. At one point, near the centre of the area, the lichen was much more abundant than in any other part.

The specimens collected at Seaford (see Figure 310) vary considerably in shape and size, and measure from one to seven centimetres in longest diameter. Very few are spherical, some are more or less flattened, and many are quite irregular. They rapidly absorb water, and while they are wet they are exceedingly soft and spongy. In this condition they rapidly break up into small fragments. Our specimens were gathered after six or eight weeks' drought. On placing some of them in water a few days after collection, it was quite easy to determine which side had been uppermost for some time before gathering. In water, the uppermost side became pale green in colour (they are greenish grey when dry); the underside remained unchanged. New growth probably takes place only on the exposed surface. This is similar to the growth of some allied, attached lichens, as that of *Parmelia omphalodes* and some forms of *Parmelia saxatilis*. The older portion is continually being covered over by younger branches, and thus the thallus shows a succession of layers.

When the plant approaches a spherical form in unattached specimens, the layers approximate to a concentric arrangement (see Figure 311), but there are often more layers in one part than in another; many of them have a hollow space in the interior. The greater number of layers on one side is perhaps accounted for by the specimens having remained on the ground in an undisturbed condition for a lengthened period, and the growth having taken place over the portion exposed to light. Before it was suggested that such erratic lichens commenced development on the branches of trees, it was thought that there might be a nucleus of growth, as a portion of rabbit's dung, or a small stone, and it was while looking for indications of such that the contents of some of the masses were noted. They all contained minute grains of sand—blown, no doubt, from the seashore—and the decaying matter of the innermost layers. After soaking in water for twenty-four hours each of six different specimens examined contained a few living and very active Bdelloid rotifers. These rotifers have been known for some time as moss-dwellers, but lichens must now be added to the list of their habitats. When dry, the lichens are comparatively light, and are probably occasionally rolled over by a strong wind. It is well to remember that with the south-west gales there is frequently heavy rain, and that by the soaking up of water the plants become comparatively heavy. Owing to the rough external structure of the thallus, these lichens come into contact with the grass at many points (see Figure 309), and this must prevent movement except when there is a very strong wind. The following results were obtained on weighing three specimens, first when dry, and then after they had been in water twenty-four hours:—

1.	Dry	·97 grm.	...	Wet	5·02
2.	„	1·14 „	...	„	7·04
3.	„	1·04 „	...	„	6·22

They are thus from five to six times heavier when thoroughly wet than when quite dry.

The thallus is moderately smooth, subcartilaginous and greenish-grey. The edges of the minute rounded, and overlapping lobes (see Figure 310) are rolled towards the under surface (revolute), producing at the end of the lobe a small hood, and making the exterior of the ball-like masses exceedingly rough to the touch. The lobed and involved (panniform) nature of the thallus produced by the revolute character and overlapping of the lobes is shown in Figures 310 and 312, the last being an enlarged portion (× 4) of the outer surface. There are no fruits (apothecia), and very few of the powdery masses (soredia), a vegetative mode of reproduction; but spermagones are fairly numerous in certain parts of the thallus of some of the older plants. The spermagones are seen as small black spots in Figure 312; each is a flask-shaped receptacle, from the interior of which minute cells are constricted. These cells are regarded either as spores or as non-motile male cells. The branches of the thallus that grow out from the margin to cover up the exposed inner portion of a broken fragment (see Figure 313) are broader, scarcely revolute, and slightly rugose, but these broader branches are in the course of time covered over by others that gradually assume the narrower revolute form. These differences, noted in the thallus at various periods of growth, have been the reason for the difficulties experienced by the older lichenologists in rightly placing this plant. The inner surface of the thallus is very dark, almost black, and is covered by numerous dark fibrils. This structure can be made out by cutting through the centre of one of the ovoid masses (see Figure 311), when the clear white medulla of the thallus and the cavity within become prominent features. One of the tests for the identification of this lichen is the application of a solution of calcium hypochlorite to the white medulla, which turns reddish. The action of this reäagent on the plant on flint described below (see Figures 314 and 317) and on the free plant is exactly the same; but one could scarcely doubt the essential identity of the two, even without this test. On comparing the lichen as it grows upon the flint (see Figure 317) with a free plant, one finds only very slight differences. The revolute character is perhaps not quite so evident in the attached specimen, and the thallus is not so congested.

There is no apparent evidence that the Seaford specimens commenced growth on the branches of trees. The nearest trees to the spot where the lichen is found are Sycamores, about three-quarters of a mile away, and on these the following lichens are

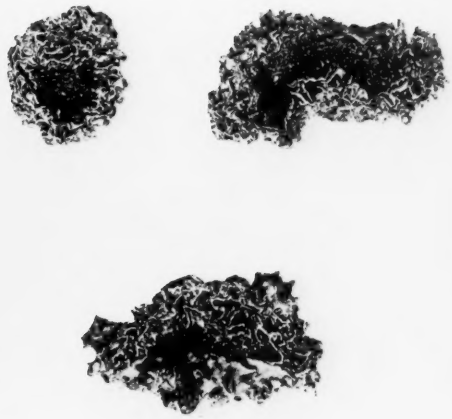

FIGURE 309.
Four specimens of *Parmelia revoluta* var. *concentrica*, photographed exactly as found on the chalk downs. × 1.

FIGURE 311. Five Lichens in section. The concentric arrangement of the layers and the central cavity in some specimens will be seen. × 1.

FIGURE 310.
The upper exposed surfaces of six specimens of different sizes. ×1.

FIGURE 312. The upper surface of a large specimen showing the imbricated arrangement of the branches. ×4.

Parmelia revoluta var. *concentrica* from photographs by Somerville Hastings.

FIGURE 313.

Six small specimens probably only recently detached from bigger ones. The large branches of the thallus growing rapidly to cover in the broken surfaces are well seen. ×1.

FIGURE 314.

Parmelia revoluta var. *panniformis* on a flint stone, photographed just as it was found. The detached fragment lying beside fitted exactly into the vacant space. ×1.

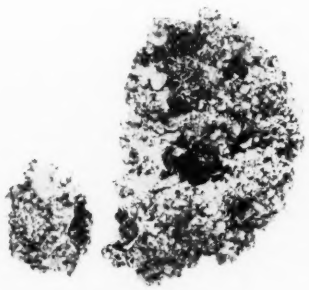

FIGURE 316.

A second specimen of *Parmelia revoluta* var. *concentrica* recently broken. It is in this way that the lichen is multiplied. ×1.

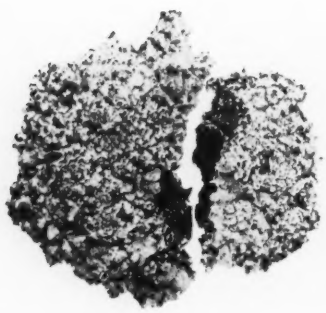

FIGURE 315.

A specimen of *Parmelia revoluta* var. *concentrica* found recently broken into two parts. ×1.

FIGURE 317.

Parmelia revoluta var. *panniformis* growing on a flint stone. The larger size of the branches at one side of the lichen should be noted. ×1½.

Parmelia revoluta vars. from photographs by Somerville Hastings.

abundant: *Plalisma glaucum*, *Everia prunastri*, *Parmelia sulcata*, *P. caparata*, *P. physodes*, *Physcia parietina*, *P. pulverulenta*, *P. tenella*, *Pertusaria communis*, *Lecidea parasema*, *Buellia canescens*, and *B. myriocarpa*. No trace of *P. revoluta* was discovered. On the bushes, fences, and flint stones near the area the following lichens were found: *Parmelia physodes*, *Physcia parietina*, and *Lecidea parasema* on bushes; *Ramalina calicaris*, *R. farinacea*, *R. fastigiata*, *Parmelia sulcata*, *P. caparata*, *Physcia polycarpa*, *Lecanora symicta* and *L. chlarona* on fences; *Physcia parietina*, *P. tenella*, *Lecanora murorum*, *L. atra*, *L. gibbosa*, *L. galestina*, *L. Paretta*, *Rhizocarpon confervoide*, and *Verrucaria nigrescens* on flints.

But on four flints only, out of several hundreds in the area we are describing, specimens of *P. revoluta* with panniform structure were found. Curiously enough, all these flints occurred towards the northen extremity of this area. While growing on the stone, the lichen assumes a panniform condition (see Figure 317), or, in other words, is built up of a series of superimposed imbricating layers. One of these stones (see Figure 314) was of peculiar interest, for lying close beside the lichen-covered flint was a detached piece, which fitted exactly into a vacant space upon the stone. It had evidently fallen off, or had been knocked off very recently. There can be no doubt that such a fragment as this might readily grow to such a typical specimen as is shown in Figure 310. We are not of the opinion that the very numerous specimens found on this small area all had their immediate origin from growth on a flint stone. From specimens collected, it appears evident that a small detached fragment is capable of growing to the size of that of the largest specimens found. Very few of these lichens growing on flints were met with, but several specimens were seen which had recently been broken into two pieces (see Figures 315 and 316). A flock of sheep driven across the downs where the lichens are found would effectually break up a great many of them, particularly on a wet day.

The wandering habit of this plant is quite unique among British lichens, but has some similarity with that of *Lecanora esculenta*, the manna of the Bible, which at certain seasons of the year breaks off from the rocks on which it grows in small masses, and is carried away by the wind, or is perhaps more frequently washed away by the rain. Kerner, in his "Natural History of Plants," Volume II, mentions the so-called rains of manna, news of which comes periodically from the East. It is clear that *P. revoluta concentrica* is blown about by the wind, but why it should be confined to so small an area is less easy to explain. It does not seem at all probable that all other parts of the downs to which it may be blown are unsuitable for its continued growth and development.

CORRESPONDENCE.

RUSSIAN PEASANTS' ARITHMETIC.

To the Editors of "KNOWLEDGE."

SIRS,—The interesting method of finding the product of two numbers, described by the Rev. G. T. Johnston, may be explained as follows:

$$\begin{array}{ll} (2^4 + 2^3r + 2^2r_1 + 2r_2 + r_3) \times n & \\ \hline 2^3 + 2^2r + 2r_1 + r_2 & 2n \\ 2^3 + 2r + r_1 & 2^3n \\ \hline 2 + r & 2^3n \\ \hline 1 & 2^4n \end{array}$$

The formation of the right-hand column is obvious. On the left side r, r_1, r_2, and so on, represent the different remainders. Their value may be 1 or 0. Working upward from 1, each successive line is formed by doubling the previous line and adding the remainder. Now let any of the remainders = 0, say r and r_2. Then the second and fourth numbers on the left are even, and on the first line the terms 2^3r and $2r_2 = 0$. The left-hand factor now becomes $2^4 + 2^2 + 1$, or 21, and the right side shows the product to be $n(2^4 + 2^2 + 1)$. Arithmetically, if $n = 23$, the result is:

$$\begin{array}{r} 21 \times 23 \\ \hline 10 \quad 46 \\ 5 \quad 92 \\ \hline 2 \quad 184 \\ 1 \quad 368 \\ \hline 483 \end{array}$$

It will be noticed that any whole number is resolvable into the sum of part of the terms of the series 1, 2, 2^2, 2^3, and so on, *e.g.*; $77 = 64 + 8 + 4 + 1 = 2^6 + 2^3 + 2^2 + 1$.

BRIGHTON. E. J. PETITFOURT.

ALKALOIDS AND COLOUR CHANGES.

To the Editors of "KNOWLEDGE."

SIRS,—The following, if new, may be of interest to some of your readers.

If into about five to ten drops of a $\frac{1}{10}$ solution of nicotine in amyl alcohol one drop of a strong solution of phosphotungstic acid (thirty grammes of soda tungstate and fifteen grammes of phosphoric acid, specific gravity 1·5, digested for some days and dissolved in two ounces of water) is allowed to fall from a height of about one-eighth inch, the drop spreads out to form a transparent disc about ·7 centimetre in diameter. Viewed by reflected light, and preferably under a low power (×20) of the microscope, the disc exhibits a series of colour changes, commencing with yellow, and running through orange, red, violet, and blue, to green, in the space of ten to fifteen seconds. This process is then repeated two or three times. The third and fourth series of changes are very slow, and the colours become gradually less distinct. The disc finally becomes white. During the first series of changes the colours are most pure and brilliant, but no colour can be perceived by transmitted light. Similar effects are produced by a solution of the oxalate of nicotine in ethyl alcohol and of nicotine in water, petroleum, ether, and chloroform. Probably they are due to the formation and gradual thickening of a film separating the two reägents.

I should be grateful if any of your readers could tell me whether the reäction constitutes a serviceable test for the alkaloid.

J. G. DREW.

THE HANNINGS,
FRESHFIELD ROAD,
BRIGHTON.

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THE FACE OF THE SKY FOR OCTOBER.

By A. C. D. CROMMELIN, B.A., D.Sc., F.R.A.S.

TABLE 42.

Date.	Sun. R.A.	Sun. Dec.	Moon. R.A.	Moon. Dec.	Mercury. R.A.	Mercury. Dec.	Venus. R.A.	Venus. Dec.	Jupiter. R.A.	Jupiter. Dec.	Saturn. R.A.	Saturn. Dec.	Uranus. R.A.	Uranus. Dec.	Neptune. R.A.	Neptune. Dec.
Greenwich Noon.	h. m.	°	h. m.	°	h. m.	°	h. m.	°	h. m.	°	h. m.	°	h. m.	°	h. m.	°
Oct. 5	12 41·9	S. 4·5	1 27·0	N.13·4	14 5·6	S.14·8	15 31·8	S.23·8	21 0·9	S.18·0	6 9·7	N.22·3	20 41·4	S.19·0	8 9·3	N.19·7
,, 10	13 0·2	6·4	5 36·0	N.28·2	14 29·2	17·3	15 48·1	25·0	21 0·8	18·0	6 10·0	22·3	20 41·2	19·0	8 9·6	19·7
,, 15	13 18·7	8·3	10 6·8	N.12·2	14 50·6	19·4	16 3·0	26·0	21 1·1	18·0	6 10·1	22·3	20 41·1	19·0	8 9·9	19·7
,, 20	13 37·4	10·1	14 39·2	S. 20·5	15 7·9	20·8	16 16·2	26·8	21 1·6	18·0	6 10·0	22·3	20 41·1	19·0	8 10·1	19·7
,, 25	13 56·4	11·9	19 53·6	S. 24·1	15 18·1	21·4	16 27·1	27·4	21 2·5	17·9	6 9·7	22·3	20 41·2	19·0	8 10·2	19·7
,, 30	14 15·6	S.13·6	23 50·1	N. 1·2	15 16·8	S. 20·7	16 35·0	S. 27·7	21 3·7	S.17·8	6 9·2	N.22·3	20 41·4	S.19·0	8 10·3	N.19·7

TABLE 43.

Date.	Sun. P	Sun. B	Sun. L	Moon. P	Jupiter. P	Jupiter. B	Jupiter. L_1	Jupiter. L_2	Jupiter. T_1	Jupiter. T_2
Greenwich Noon.	°	°	°	°	°	°	°	°	h. m.	h. m.
Oct. 5	+ 26·3	+6·5	171·0	−20·8	−18·4	+0·1	10·5	299·4	9 34 *e*	11 37 *e*
,, 10	26·4	6·2	105·1	− 3·0	18·4	0·1	79·7	330·4	9 50 *m*	2 54 *m*
,, 15	26·3	5·8	39·1	+19·0	18·4	0·1	148·8	1·4	5 47 *e*	9 54 *e*
,, 20	26·1	5·4	333·2	+17·3	18·4	0·1	217·8	32·2	3 54 *e*	11 8 *m*
,, 25	25·7	5·0	267·2	− 9·7	18·5	0·1	286·6	62·9	4 11 *m*	0 21 *m*
,, 30	+ 25·0	+4·5	201·3	−22·1	−18·6	+0·1	355·4	93·6	9 59 *e*	7 22 *e*

P is the position angle of the North end of the body's axis measured eastward from the North Point of the disc. B, L are the helio-(planeto-)graphical latitude and longitude of the centre of the disc. In the case of Jupiter, System I refers to the rapidly rotating equatorial zone, System II to the temperate zones, which rotate more slowly. To find intermediate passages of the zero meridian of either system across the centre of the disc, apply to T_1, T_2 multiples of $9^h\ 50^m{\cdot}6$, $9^h\ 55^m{\cdot}8$ respectively.

The letters *m*, *e*, stand for morning, evening. The day is taken as beginning at midnight.

THE SUN is moving southward but with slackening speed. Its semi-diameter increases from 16′ 0″ to 16′ 8″. Sunrise changes from $5^h\ 59^m$ to $6^h\ 53^m$; sunset from $5^h\ 41^m$ to $4^h\ 35^m$.

MERCURY is an evening star, at elongation 25° from Sun on 15th. Semi-diameter increases from 3″ to 4½″. Illumination diminishes 0·8 to 0·2.

VENUS is an evening star, ⅓ of disc illuminated. Semi-diameter 18″. At greatest brilliancy on 23rd. The fact of its declination being south of the Sun impairs the conditions of observation for northern observers. It has passed elongation, and is approaching the Sun.

THE MOON.—Full $4^d\ 5^h\ 59^m$ *m*. Last quarter $12^d\ 9^h\ 33^m$ *m*. New $19^d\ 6^h\ 33^m$ *m*. First quarter $25^d\ 10^h\ 44^m$ *e*. Apogee $6^d\ 5^h$ *e*. Perigee $19^d\ 4^h$ *e*, semi-diameter 14′ 44″, 16′ 45″ respectively. Maximum librations 8^d 7° S., 13^d 7° E., 21^d 7° N., 25^d 7° W. The letters indicate the region of the Moon's limb brought into view by libration. E., W. are with reference to our sky, not as they would appear to an observer on the Moon (see Table 45).

MARS is practically invisible.

JUPITER is an evening star, in Capricornus, 26′ South of θ Capricorni on September 30th and on October 16th. Polar semi-diameter, 20″. Stationary on 9th; 1° N. of Moon on 26th.

Configuration of satellites at 8^h *e* for an inverting telescope.

JUPITER'S SATELLITES.

Day.	West.		East.		Day.	West.		East.	
Oct. 1	431	○	2		Oct. 17	3412	○		
,, 2	432	○	1		,, 18	43	○	12	
,, 3	431	○		2●	,, 19	412	○	3	
,, 4	4	○	12	3●	,, 20	42	○	13	
,, 5	421	○	3		,, 21	4	○	23	1●
,, 6	42	⊙	3		,, 22	413	○	2	
,, 7	4	○	132		,, 23	342	○	1	
,, 8	31	○	42		,, 24	3142	○		
,, 9	32	○	14		,, 25	3	○	142	
,, 10	31	○	4	2●	,, 26	1	⊙	34	
,, 11	3	○	124		,, 27	2	○	134	
,, 12	21	○	34		,, 28	1	⊙	234	
,, 13	2	○	134		,, 29		⊙	24	
,, 14		○	234	1●	,, 30	32	○	14	
,, 15	13	○	24		,, 31	31	○	4	
,, 16	32	○	41						

On the 29th, Satellites 1, 3 are both on the disc.

The following satellite phenomena are visible at Greenwich, $1^d\ 10^h\ 35^m\ 56^s$ *e*, II. Tr. I.; $2^d\ 0^h\ 48^m\ 4^s$ *m*, II. Sh. I.; $3^d\ 9^h\ 53^m\ 42^s$ *e*, II. Ec. R.; $4^d\ 8^h\ 25^m\ 28^s$ *e*, III. Oc. R.; $9^h\ 23^m\ 50^s$ *e*, III. Ec. D.; $11^h\ 43^m\ 1^s$ *e*, I. Tr. I.; $5^d\ 9^h\ 2^m\ 34^s$ *e*, I. Oc. D.; $6^d\ 0^h\ 29^m\ 34^s$ *m*, I. Ec. R.; $6^h\ 10^m\ 39^s$ *e*, I. Tr. I.; $7^h\ 19^m\ 53^s$ *e*, I. Sh. I.; $8^h\ 27^m\ 52^s$ *e*, I. Tr. E.; $9^h\ 37^m\ 11^s$ *e*, I. Sh. E.; $7^d\ 6^h\ 58^m\ 23^s$ *e*, I. Ec. R.; $8^d\ 6^h\ 33^m\ 18^s$ *e*, IV. Oc. R.; $10^d\ 7^h\ 9^m\ 32^s$ *e*, II. Oc. D.;

$11^d\ 8^h\ 28^m\ 57^s\ e$, III. Oc. D.; $12^d\ 0^h\ 7^m\ 59^s\ m$, III. Oc. R.; $7^h\ 33^m\ 29^s\ e$, II. Sh. E.; $10^h\ 53^m\ 32^s\ e$, I. Oc. D.; $13^d\ 8^h\ 2^m\ 2^s\ e$, I. Tr. I.; $9^h\ 15^m\ 29^s\ e$, I. Sh. I.; $10^h\ 19^m\ 12^s\ e$, I. Tr. E.; $11^h\ 32^m\ 44^s\ e$, I. Sh. E.; $14^d\ 5^h\ 21^m\ 30^s\ e$, I. Oc. D.; $8^h\ 53^m\ 40^s\ e$, I. Ec. R.; $15^d\ 6^h\ 1^m\ 39^s\ e$, I. Sh. E.; $6^h\ 52^m\ 57^s\ e$, III. Sh. E.; $16^d\ 10^h\ 47^m\ 5^s\ e$, IV. Tr. I.; $17^d\ 9^h\ 39^m\ 45^s\ e$, II. Oc. D.; $19^d\ 7^h\ 19^m\ 31^s\ e$, II. Sh. I.; $7^h\ 38^m\ 3^s\ e$, II. Tr. E.; $10^h\ 9^m\ 37^s\ e$, II. Sh. E.; $20^d\ 9^h\ 54^m\ 36^s\ e$, I. Tr. I.; $11^h\ 11^m\ 9^s\ e$, I. Sh. I.; $21^d\ 7^h\ 13^m\ 58^s\ e$, I. Oc. D.; $10^h\ 48^m\ 57^s\ e$, I. Ec. R.; $22^d\ 5^h\ 39^m\ 32^s\ e$, III. Tr. E.; $5^h\ 40^m\ 5^s\ e$, I. Sh. I.; $6^h\ 40^m\ 7^s\ e$, I. Tr. E.; $7^h\ 17^m\ 16^s\ e$, III. Sh. I.; $7^h\ 57^m\ 21^s\ e$, I. Sh. E.; $10^h\ 54^m\ 27^s\ e$, III. Sh. E.; $23^d\ 5^h\ 17^m\ 47^s\ e$, I. Ec. R.; $25^d\ 7^h\ 4^m\ 42^s\ e$, IV. Ec. D.; $26^d\ 7^h\ 19^m\ 46^s\ e$, II. Tr. I.; $9^h\ 55^m\ 54^s\ e$, II. Sh. I.; $10^h\ 10^m\ 5^s\ e$, II. Tr. E.; $28^d\ 7^h\ 6^m\ 40^s\ e$, II. Ec. R.; $9^h\ 7^m\ 39^s\ e$, I. Oc. D.; $29^d\ 5^h\ 57^m\ 27^s\ e$, III. Tr. I.; $6^h\ 17^m\ 0^s\ e$, I. Tr. I.; $7^h\ 35^m\ 49^s\ e$, I. Sh. I.; $8^h\ 34^m\ 12^s\ e$, I. Tr. E.; $9^h\ 35^m\ 4^s\ e$, III. Tr. E.; $9^h\ 53^m\ 6^s\ e$, I. Sh. E.; $30^d\ 7^h\ 13^m\ 6^s\ e$, I. Ec. R.

Eclipses will take place to the right of the disc in an inverting telescope, taking the direction of the belts as horizontal.

SATURN is a morning star, in Gemini. Stationary on 15th. Polar semi-diameter 9″. Major axis of ring 44½″, minor 19½″. Angle P−6°·3.

Eastern elongations of Tethys (every 4th given) $1^d\ 10^h\cdot9\ m$, $9^d\ 0^h\cdot2\ m$, $16^d\ 1^h\cdot4\ e$, $24^d\ 2^h\cdot6\ m$, $31^d\ 3^h\cdot8\ e$; of Dione (every 3rd given) $6^d\ 4^h\cdot7\ m$, $14^d\ 7^h\cdot8\ m$, $22^d\ 2^h\cdot9\ e$, $30^d\ 7^h\cdot9\ e$; of Rhea (every 2nd given) $4^d\ 10^h\cdot6\ e$, $13^d\ 11^h\cdot4\ e$, $23^d\ 0^h\cdot3\ m$.

For Titan and Japetus E., W. stand for East and West elongations, I for Inferior (North) conjunction, S. for Superior (South) conjunction. Titan $4^d\ 5^h\cdot0\ m$ I, $8^d\ 2^h\cdot0\ m$ W., $12^d\ 2^h\cdot1\ m$ S., $16^d\ 4^h\cdot5\ m$ E., $20^d\ 3^h\cdot7\ m$ I., $24^d\ 0^h\cdot8\ m$ W., $28^d\ 0^h\cdot9\ m$ S; Japetus $14^d\ 3^h\cdot8\ m$ S.

URANUS is an evening star in Capricornus, stationary on 18th, 2° North of Moon on 26th.

NEPTUNE is a morning star, coming into a better position for observation. Stationary on November 3rd.

METEOR SHOWERS (from Mr. Denning's List):—

Date.	Radiant. R.A.	Radiant. Dec.	Remarks.
	°	°	
July-October...	355	+ 72	Swift, short.
Aug.-Oct. 2...	74	+ 42	Swift, streaks.
Sept. 28-Oct. 9	320	+ 40	Slow small.
Oct. 2 ...	230	+ 52	Slow, bright.
,, 4 ...	310	+ 79	Slowish.
,, 8 ...	77	+ 31	Swift, streaks,
,, 8-14 ...	45	+ 58	Small, short.
,, 14 ...	133	+ 68	Rather swift.
,, 15 ...	31	+ 9	Slow.
,, 18-20 ...	92	+ 15	Swift, streaks.
,, 23 ...	100	+ 13	Swift, streaks.
,, 29 ...	109	+ 23	Very swift.

In the cases where the radiant is stated to be active for several months, there is a difference of opinion as to whether it can be regarded as a single shower or a combination of several.

TABLE 44. NON-ALGOL STARS.

Star.	Right Ascension.	Declination.	Magnitudes.	Period.	Date of Maximum.
	h. m.	°		d.	
SV Andromedae	0 0	+39·6	8·0 to 13·0	318	Nov. 10.
T Ceti	0 17	−20·5	5·4 to 6·9	162·2	Nov. 15.
T Cassiopeiae..	0 19	+55·3	6·7 to 12·5	443·0	Dec. 24.
TU Andromedae	0 28	+25·5	7·7 to 11·5	317	Sept. 9.
RV Cassiopeiae	0 48	+47·0	8·0 to 14·5	327	Sept. 6.
R Piscium	1 26	+ 2·4	7·0 to 14·0	344·2	Dec. 14.

Minima of Algol $3^d\ 4^h\cdot7\ e$, $15^d\ 4^h\cdot0\ m$, $18^d\ 0^h\cdot8\ m$, $20^d\ 9^h\cdot6\ e$, $23^d\ 6^h\cdot5\ e$, $26^d\ 3^h\cdot3\ e$. Period $2^d\ 20^h\ 48^m\cdot9$.

Principal Minima of β Lyrae October $10^d\ 4^h\ e$, $23^d\ 2^h\ e$. Period $12^d\ 21^h\ 47^m\cdot5$.

TABLE 45. Occultations of stars by the Moon visible at Greenwich.

Date.	Star's Name.	Magnitude.	Disappearance. Time.	Disappearance. Angle from N. to E.	Reäppearance. Time.	Reäppearance. Angle from N. to E.
1914.			h. m.	°	h. m.	°
Oct. 1 ...	λ Aquarii	3·9	6 0 *e*	42	7 8 *e*	255
,, 1 ...	78 Aquarii	6·3	7 31 *e*	26	8 36 *e*	265
,, 7 ...	μ Arietis...	5·7	0 15 *m*	130	0 44 *m*	173
,, 10 ...	BAC 1648	6·4	2 24 *m*	26	3 9 *m*	319
,, 10 ...	BAC 1918..	6·1	—	—	7 59 *e*	327
,, 11 ...	39 Geminorum	6·2	—	—	9 9 *e*	257
,, 11 ...	40 Geminorum	6·3	—	—	9 13 *e*	211
,, 12 ...	Wash. 495	6·9	—	—	3 16 *m*	216
,, 12 ...	BD+23°·1863	6·7	—	—	11 34 *e*	251
,, 23 ...	BAC 6160	6·4	5 17 *e*	85	6 28 *e*	256
,, 26 ...	η Capricorni	4·8	4 23 *e*	89	5 34 *e*	219
,, 26 ...	Wash. 1407	6·7	7 9 *e*	3	—	—
,, 28 ...	Wash. 1513	6·8	5 12 *e*	129	—	—
,, 28 ...	BAC 7919	6·5	8 3 *e*	1	8 51 *e*	284
,, 30 ...	14 Piscium	5·9	1 39 *m*	7	2 17 *m*	293
,, 31 ...	δ Piscium	4·6	4 45 *e*	98	5 34 *e*	198

From New to Full disappearances take place at the Dark Limb, from Full to New reäppearances.

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COMETS.—See "Notes on Astronomy" in August "KNOWLEDGE." Delavan's Comet promises to be an easy object to the naked eye.

DOUBLE STARS AND CLUSTERS.—The tables of these given two years ago are again available, and readers are referred to the corresponding month of two years ago.

VARIABLE STARS.—The list will be restricted to two hours of Right Ascension each month. The stars given in recent months continue to be observable (see Table 44).

SOLAR DISTURBANCES DURING JULY, 1914.

By FRANK C. DENNETT.

DURING July the Sun was telescopically observed each day, the disc appearing quite free from disturbance on seven days (1st, 15th, and 23rd to 27th), and on nine others (13th, 14th, 16th, 19th to 21st, 28th, 29th, and 31st) only faculae were seen. Outbreaks showed a marked preponderance in the southern latitudes. The longitude of the central meridian at noon on July 1st was 359° 48′.

No. 18.—A somewhat complicated outbreak. At first it was seen on July 2nd, in latitude 37° S., but became reduced to a pore on the 6th and 7th. The more advanced portion developed later, and was the most conspicuous, and was in latitude 32°, and contained a spot at one time seventeen thousand miles in length. The total length of the group was nearly one hundred thousand miles. The preceding portion continued visible until the 12th, but its great faculic remains were seen for two days longer.

No. 19.—A small penumbraless pore, only seen on the 7th.

No. 20.—A group of three pores, twenty-eight thousand miles in length, only seen on July 11th.

No. 21.—Another group of pores, twenty-seven thousand miles in length, showing a considerable amount of change, seen only on the 17th and 18th, containing at one time eight members.

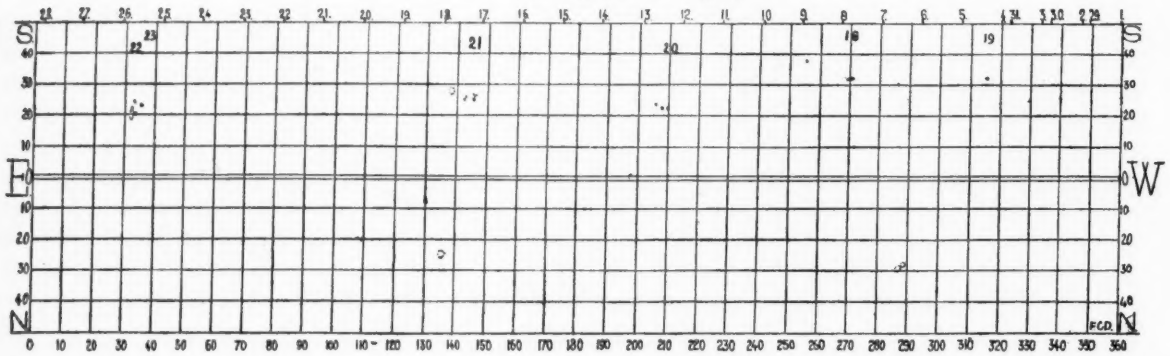
No. 22.—A single pore, on the western side of a faculic disturbance, only visible on the 22nd.

No. 23.—Two pores, the larger leading, in a faculic bed, only seen on the 29th and 30th, but the faculae were visible until the limb was reached on August 1st.

The area in which these last two groups developed was marked by a faculic disturbance near the south-western limb on July 3rd and 4th. No. 20 broke out in a district seen faculic within the south-eastern limb, July 7th to 10th, and within the south-western limb, 17th to 20th. Other faculae were seen north-west, on the 16th and 17th; north-east on 7th, 12th, on chart 136°, 25° N., 13th and 28th, 289°, 30° N.; east on 29th; south-west on the 13th and 14th, 22nd on chart at 139°, 29° S., and 31st; likewise south-east on the 20th and 21st.

Our chart is constructed from the combined observations of Messrs. John McHarg, J. C. Simpson, and the writer.

DAY OF JULY, 1914.



ON THE IDENTIFICATION OF THE NEREÏDAE OF PLYMOUTH BY MEANS OF THEIR PARAPODIA.

BY W. HAROLD LEIGH-SHARPE, B.Sc., A.C.P.

As it frequently happens that Nereïds die with the pharynx unextruded, so that the denticles, or paragnaths, thereon cannot be observed, and that species described in the text-books as reddish are often green, and *vice versa*, the only safe means of identification is by cutting off the parapodia of an animal, mounting them in a drop of Farrant's medium, and examining them under the low power of a microscope, when one glance at the accompanying figures will clearly determine which of the species is under consideration.

In the figures the following notation is adopted :—

D.c. Dorsal cirrus.
1. The dorsal lobe of the Notopodium (often referred to in books as the Ligula).
2. The ventral lobe of the Notopodium.
3. The dorsal lobe of the Neuropodium.
4. The ventral lobe of the Neuropodium.
V.c. Ventral cirrus.

The acicula are shown as deep black lines. The names in brackets in the descriptions before those of the species are the generic names bestowed upon them by Malmgren, but the differences, it is now universally agreed, are only of specific value, and do not justify the erection of separate genera. Incidentally, at the time he bestowed those names upon them he was ignorant of the meaning of the Heteronereïs form. In general, it may be remarked that—

Nereïs dumerilli and *N. irrorata* may be distinguished by the greater length of their peristomial tentacles (in proportion).

N. fucata lives in the topmost whorls of whelk shells, in those occupied, or recently deserted, by hermit crabs. The peculiarities of its parapodia are visible to the unaided eye.

As the parapodia vary slightly in different parts of the body, the examples chosen are selected from as near as possible half-way down the length of the body.

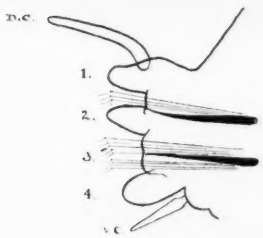


FIGURE 318.

Nereïs pelagica.

The whole section has a squat, square appearance. Lobes 1 and 2 are the *same length.* Lobes 1, 2, and 4 have rounded extremities. The ventral cirrus is longer than lobe 4. The acicula are as near as possible *parallel* and *transversely* set.

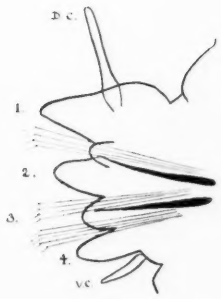


FIGURE 319.

N. cultrifera. The most central type.

Lobe 1 is the longest, and has a more pointed tip.

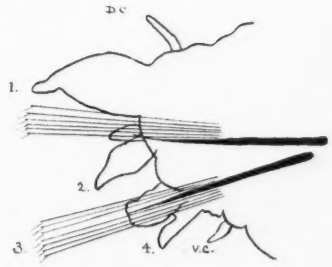


FIGURE 320.

N. (Hediste) diversicolor.

Dorsal cirrus not as long as Lobe 1. Lobe 1 of characteristic shape. *Extreme reduction* of ventral cirrus.

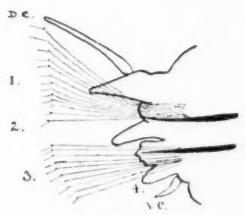


FIGURE 321.

N. (Leontis) dumerilli.

A more rugged outline, especially in Lobe 3. Chaetae more numerous, long, and spread out like a fan. Acicula *parallel* but *obliquely* set.

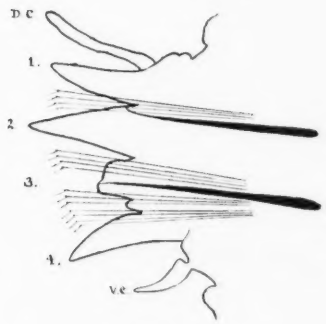


FIGURE 322.

N. (Eunereïs) longissima.

Easily identified as the only one in which *Lobe 2 is longer* than Lobe 1. Chaetae short, hardly as long as the parapodia. Acicula *parallel,* somewhat *obliquely* set.

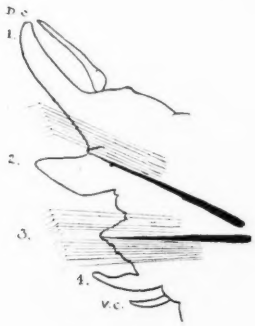


FIGURE 323.

N. (Praxithea) irrorata.

Lobe 1 very elongated. Lobe 1 and the dorsal cirrus curve towards one another with a "claw-like" effect, which may be spoilt by bad mounting. Lobe 4 and ventral cirrus small.

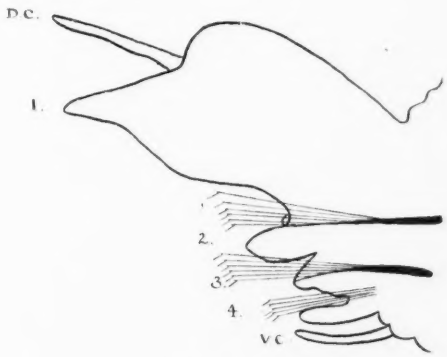


FIGURE 324.

N. (Nereïlepas) fucata.

Characteristic expansion proximal to the dorsal cirrus and Lobe 1.

Parapodia of Plymouth Nereïds.

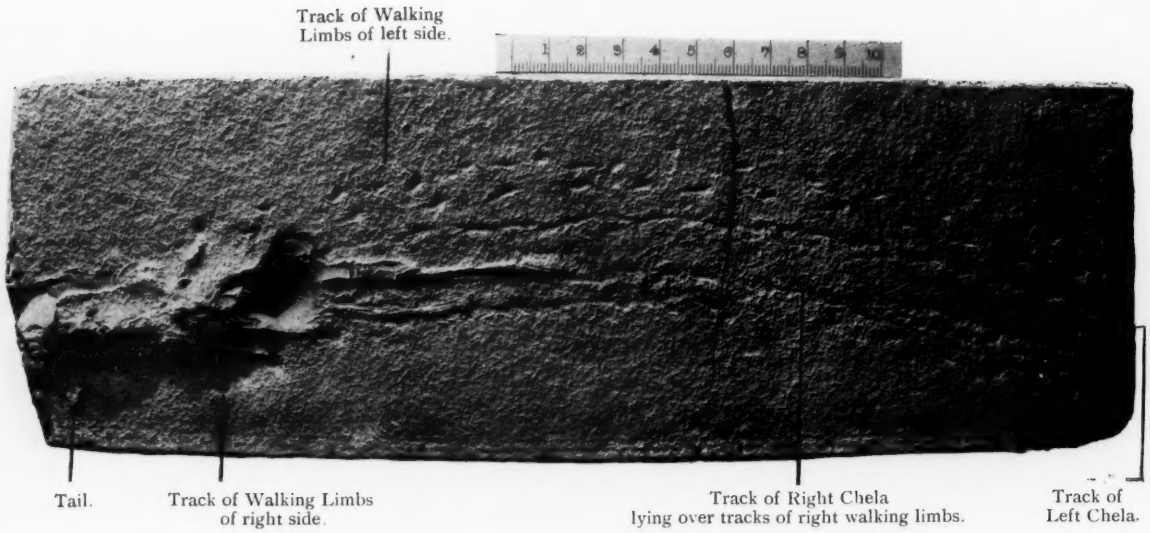


FIGURE 325. The fossil tracks of a dying Lobster (see page 329).

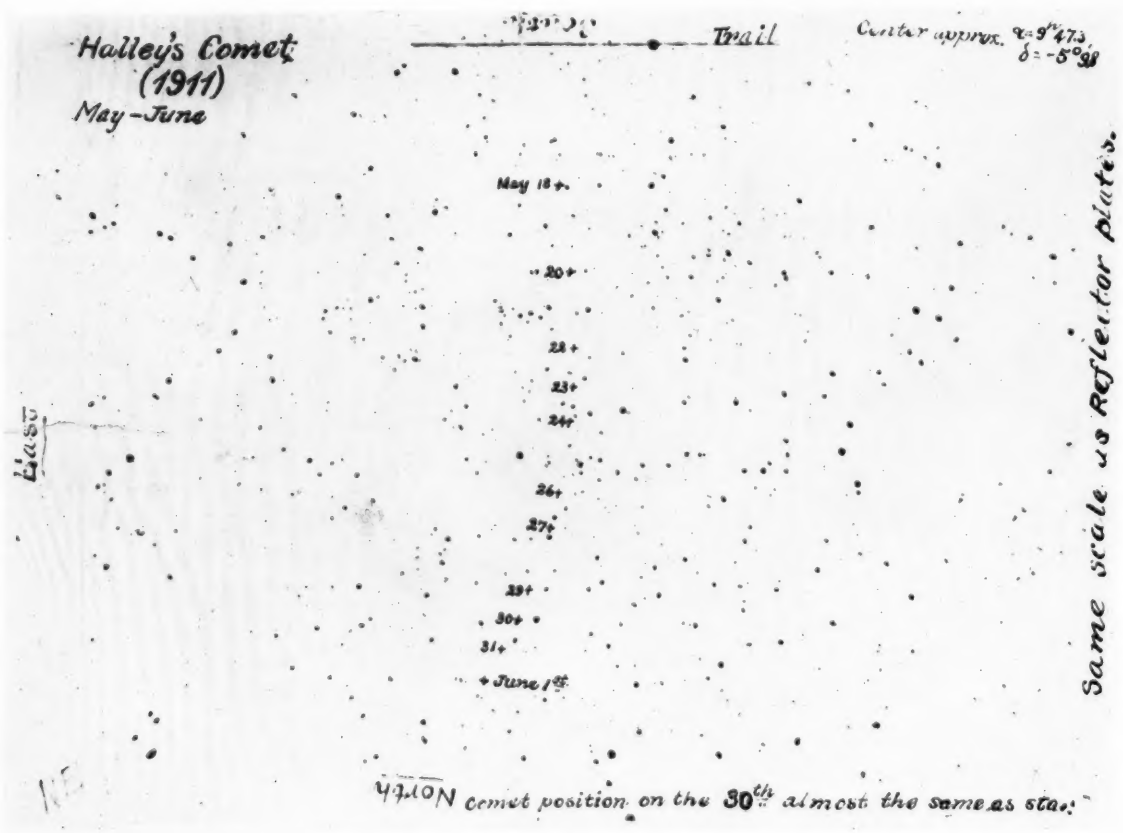


FIGURE 326. Chart of the last views from Earth of Halley's Comet. Photographed at the Lowell Observatory. Near the star ALPHARD (see page 329).

THE FOSSIL TRACK OF A DYING LOBSTER.

By Dr. F. A. BATHER, F.R.S.

(By permission of the Trustees of the British Museum.)

In his admirable bionomic study of the Kimmeridgian Plattenkalk of Solnhofen in Bavaria (*Haeckel Festschrift*, Jena, 1904), Dr. Johannes Walther remarks that "the overwhelming majority of crustaceans lie flat and peacefully on the limestone surface, the feet outspread or slightly bent, and usually in connection with the cephalothorax, the long antennae frequently preserved to their very ends, the bristles on the abdominal margin or on the tail clearly raised above the stone; and the completely preserved specimens so predominate that only in *Penaeus* can traces of a death-struggle be suspected. For the rest, no grooving, no sculpture of the limestone surface, suggests any agony. Everyone knows that the living crayfish, when placed in boiling water, bends its tail up under the cephalothorax, and holds it firmly in that position, whereas crustaceans already dead have the body stretched out. It is only in a few slabs with *Aeger* that I have seen the body so bent."

It is therefore interesting to note that the Geological Department of the British Museum has recently acquired a specimen of *Mecochirus longimanus* Münster, one of the Glyphaeidae, which affords direct evidence concerning the last few minutes of its life. The animal lies at one end of a slab of lithographic stone, 29·5 centimetres by 10 centimetres, with its tail, which is curled in, near one end-margin of the slab, and the long chelae, from which the animal derives its name, stretched along the length of the slab. Proceeding from the animal, in the direction of the chelae, are various lines of impressions, indicating that the animal had been crawling backwards. The lines on the left (top in Figure 325), formed by the walking limbs on that side of the body, are the most deeply marked. The reason for this appears from the fact that they are arranged in a wide curve, with a radius of about thirty-two centimetres, so that these limbs were exerting more force than the others as they slewed the animal round. The imprints of the corresponding limbs on the right side are also visible in the immediate neighbourhood of the body, but further away from it are obscured by the tracks of the chelae, which, as the animal curved round, came over the inner lines of track. The chelae do not at present lie immediately on the lines traced by them, but the left-hand one at all events has been swung well over to the right, probably at the moment when the animal finally fell over on its left side and turned up its tail. Even before this it is possible that there were some sweeping movements of the chelae from side to side. The traces of such movement are very obscure, but Dr. Calman, who has kindly examined the specimen with me, thinks that he can see a few faint cross-ridges.

Professor Walther believes that most of the remains of crustaceans, not to mention several other forms of life, found in the Plattenkalk were dead before they were swept into the basin where it was rapidly accumulating. Here, however, we have one that was certainly still alive, and we should like to know just why it died. It was not of old age, for it was by no means so fully grown as many examples of this common species. There are no signs of disease or of any attack by another animal, but the specimen is too poorly exposed to permit of a definite pronouncement on the latter point. Probably the cause was something in the surrounding conditions. The tracks left by various animals (*Archaeopteryx*, among others) are enough to prove that the water was in many places very shallow indeed, often, it may be, little more than a film, if, indeed, the bottom was not temporarily exposed. In this particular case, one can hardly imagine these tracks being made so definitely and preserved so clearly if the bottom were of ooze covered with water. They are more like the imprints left on a mud-flat; and the substance must have had some time to consolidate before it was covered by the next deposit of ooze. The natural conclusion seems, therefore, to be that the animal had been wave-borne, or wind-swept, or even carried by some fishing form, half reptile and half bird, out of its natural habitat, and dropped on a mud-flat exposed for a time to the direct rays of the sun. Why it did not crawl forwards we cannot say; perhaps it had suffered some damage. At any rate, it began to crawl backwards, hoping, if one may so express it, to win again to deeper and cooler water. Unfortunately for itself, but fortunately for us, it was overcome on the way. It is now exhibited in Gallery 8 of the Geological Department, and bears the register number I 16137.

NOTES.

ASTRONOMY.

By A. C. D. Crommelin.

PROFESSOR BARNARD'S OBSERVATIONS OF HALLEY'S COMET.—A most interesting account of Professor Barnard's visual and photographic observations of this famous comet is contained in the *Astrophysical Journal* for June last. He points out that, in addition to the sentimental interest attaching to its long history of two thousand years, it was remarkable for the great apparent length of its tail, 120° or more, which seems to be unsurpassed. This was due to the nearness of the comet to us in May, 1910, since the length in miles was not extraordinary. I am glad to see that Professor Barnard combats the erroneous impression that the late return of the comet ought to be regarded as a disappointment. It is quite true that in northern latitudes its low altitude and the prolonged twilights of May robbed it of much of its splendour; but in this country at least the public were fully forewarned of these unfavourable conditions. The accounts of observers in the tropics or southern hemisphere are of a most enthusiastic character, describing the tail as a magnificent searchlight beam, ascending from the eastern horizon to the zenith, and even further.

I notice that he favours the view that the Earth did actually penetrate a portion of the tail. He notes the presence on 1910, May 17th and 18th, of a lower band, fainter but broader than the main beam, that involved the ecliptic, and was evidently more than long enough to reach the Earth. This was independently seen by Miss Mary Proctor, Professor D. P. Todd, Mr. Innes in the Transvaal, Dr. F. C. Cook and Professor Perrine in the Argentine Republic.

As regards phenomena that might be associated with the passage of the tail, he says: "The forenoon of May 19th developed peculiarities that were very suggestive . . . a peculiar iridescence and unnatural appearance of the clouds near the Sun and a bar of prismatic light on the clouds in the south. The entire sky had a most unnatural and wild look." The abnormal conditions began about noon on the 19th. He refers to similar observations in the Transvaal, etc., and I may add that I myself noticed a remarkable columnar structure of the clouds on the following night at Greenwich. Professor Barnard gives, as a further

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effect of our passage through the tail, an account of an appearance of slowly moving steps and masses of self-luminous haze, first seen on the night of June 7th, 1910, and continuing for a year. To these appearances we may add the phenomenon known as " Bishop's ring," which was seen round the Sun, as in 1883, after the Krakatoa eruption. Possibly, also, the widespread thunderstorm which occurred on the night of the passage deserves to be put on record.

The detailed sketches of the nucleus made with the forty-inch refractor show two bright wings with parabolic outlines, pointing one to north, one to south. These are similar to some drawings of the comet made in 1835, and show that the type of a comet may at times persist, in spite of the continual changes going on.

A beautiful series of photographs was obtained with the ten-inch lens, several being reproduced in the article.

The photograph of June 6th, 1910, in combination with those made at Honolulu and Beirut, enabled the acceleration of the tail matter to be measured. In an interval of seven and a half hours the speed of recession from the Sun increased from sixty-four to eighty-six kilometres per second. The recession from the nucleus increased from thirty-seven to sixty kilometres per second.

The receding matter seemed to be a complete discarded tail, having outlines similar to those of the main tail, but rapidly receding from it. A Kodaikanal photograph, taken in April, 1910, showed a similar phenomenon. It is curious that immense jets of tail matter can apparently retain their individuality, and recede more or less as a single entity, in spite of the inconceivable tenuity of their substance.

The comet was observed visually for the first time by Professor Burnham, at Yerkes, on September 15th, 1909. Professor Barnard notes that it was then much brighter than the limit of visibility with the forty-inch, so that it might have been seen earlier but for the unfavourable position in the sky. The last visual observation with the forty-inch was May 23rd, 1911. It was photographed at Flagstaff for a few days longer till June 1st. Professor Lowell has sent me a print illustrating the Flagstaff photographic observation from May 18th to June 1st, 1911 (see Figure 326).

It is interesting to read that many people took the precaution to stop up key-holes and cracks in windows to keep out the deadly comet gases. Professor Barnard thinks that some scientific writers are to blame for having misled the public as to this risk.

STUDIES ON STAR MOTIONS. Professor C. V. L. Charlier has published an essay in the *Meddelanden* of the Lund Observatory, in which he analyses the distribution of the proper motions in the " Preliminary General Catalogue " of Boss. He divides the sky into forty-eight squares, and finds the arrangement of proper motions, as regards direction and magnitude, in each of them. The combined result for the solar apex is :—

	R.A.	N. Dec.
Stars of 4th mag. to 5th mag. ...	267°...	35°
Stars of 5th mag. to 6th mag. ...	273°...	31°

Assuming that the solar speed is twenty kilometres per second (after Campbell), he finds that the average parallax of the stars of magnitude five and a half is 0″·011, and their mean distance twenty-nine and a half siriometers (a term he uses to denote a million astronomical units). Kapteyn had found 0″·016, but his result was based on less complete data.

He then examines the rival theories of " Two Star Streams " versus " The Ellipsoidal Distribution of Velocities " (Schwarzschild), and favours the latter one, showing that it implies that " the mean velocity in the direction of the vertex is about double that at right angles to this direction." He also discusses the theory of Professor Turner that the stars are moving in elongated elliptical orbits about a centre. He finds that he can explain on this theory a certain want of symmetry in the velocity distributions, which would arise in case the Sun were near the centre of motion, but not quite coincident with it. He favours the theory without reaching a definite conclusion about it.

The next question that arises is whether the law that holds in gaseous mixtures (the mean energy being the same for all particles, *i.e.*, the velocity varying inversely as the square root of the mass) holds in the stars of different type. With the aid of results obtained by Kapteyn and Wicksell the following table is arrived at :—

Spectral type.	Absolute mag.	μ = Mass.	$1/\sqrt{\mu}$	Vel. in kms. per sec.	Vel. in units of Type F.
	m.				
B	−2·31	5·21	0·44	6·4	0·44
A	+1·47	1·63	0·78	10·5	0·73
F	+3·07	1·00	1·00	14·4	1·00
G	+3·85	0·79	1·13	15·9	1·10
K	+4·10	0·73	1·17	16·8	1·17
M	+8·17	0·21	2·19	17·1	1·19

It will be seen that the agreement between the fourth and sixth columns is remarkably good, except in the case of M stars. This leads us to conclude that the doctrine of the " equipartition of energy among the stars " is approximately true. The failure in the case of the M stars may perhaps be explained by Professor H. N. Russell's result that these should be divided into two classes—the Giants and the Dwarfs.

Professor Charlier reminds us that the small bodies of the solar system do not exhibit the equipartition of energy. However, their velocities are impressed on them by a single mighty mass—the Sun—and their case is not quite analogous to that of isolated stars that are only under the influence of the combined attraction of the stellar universe.

One noteworthy feature of this important essay is that, though it emanates from Sweden, it is written in English —and very good English, considering that the author is a foreigner. This compliment to our language is paid also by several other numbers of the Lund *Meddelanden*.

THE WAR AND THE SOLAR ECLIPSE.—War leads to many tragedies, but as astronomers we cannot help giving a moment's thought to its lamentable effect on the observation of the eclipse. Many who had planned to observe it are prevented from going at all. Others reached their stations before the outbreak of hostilities, but they are likely to suffer much inconvenience and hardship on their return journey, even if their actual observational work is not interfered with, as it may be, by military exigencies.

Two other cases occur to me where astronomical observations were hampered by war. A French astronomer, Le Gentil, was taken prisoner on his way to observe the transit of Venus of 1761, and was not released till too late. He remained in Asia to observe the transit of 1769, but his desires were frustrated by cloud. M. Jannsen escaped by balloon from the siege of Paris, in December, 1870, to observe the eclipse of the Sun in Algeria.

BOTANY.

By PROFESSOR F. CAVERS, D.Sc., F.L.S.

PLANKTON (FLAGELLATES AND GREEN ALGAE) OF THE ADRIATIC. (*Continued from page* 306.)— In his second paper Schiller describes new species of Chlamydomonadales (*Pyramimonas, Carteria, Chlamydomonas,* and *Cymbomonas* nov. gen.), and gives biological

notes on the Flagellata and Chlorophyceae in the Adriatic plankton. These are most abundant in the warm months, June to September, beginning rapidly in February and gradually increasing until they attain their maximum in August with over sixty-seven thousand per litre, after which they rapidly diminish to the winter minimum.

As in the case of the Coccolithophoridae (see preceding notice), these minute components of the phytoplankton swarm in the sea at the warmest period, during which the net-obtained plankton (the larger forms) are scarce, and this gives them great importance as producers of organic substance. Among the Flagellate groups the Chrysomonads, Cryptomonads, and Euglenineae were obtained throughout the year, while the Chloromonads were observed only in February and March, and then but sparingly. As regards horizontal distribution, the northern part of the Adriatic (north of a line drawn from Ortona on the Italian to Sebenico on the Dalmatian coast) is richer in these naked phytoplankton forms than the southern part, and these are particularly abundant in the littoral waters under the influence of the fresh water from the Italian rivers up to twenty or thirty sea miles from the Italian coast. On the Dalmatian side the corresponding zone is much narrower and somewhat poorer in these forms. The conditions are similar in the southern Adriatic, the forms mentioned being here also neritic, but much less abundant. The marked influence of the inflowing fresh waters on the abundance of the Flagellata and Chlorophyceae, and of the phytoplankton in general, is strikingly shown by a comparison between the two shores, the Italian littoral with its numerous rivers, especially the Po, showing a much richer phytoplankton than the Dalmatian coast, with its fewer and less voluminous streams. Comparisons of vertical distribution show that in May the maximum of Flagellata and Chlorophyceae is at twenty metres depth with about twenty-nine thousand individuals per litre, and in August at fifty metres depth with about sixty-two thousand; in August the number of individuals per litre is nearly double that found in the surface water. Since the quantitative increase from the surface to fifty metres depth is very gradual, it may be inferred that the rapidly diminishing temperature from above downwards has very little influence on the vertical distribution of these forms, and that light and probably also salt-content play the chief rôles in its determination. The results obtained give convincing evidence that the minute plankton obtained by centrifuge and filter plays a much more important part than has hitherto been supposed in producing organic substance by their carbon assimilation.

A NEW FRESHWATER "FLORA."—Under the title of "Der Süsswasser Flora" a most important new work is now being published by G. Fischer, of Jena. The work is to be completed in sixteen volumes, of which seven have already appeared, each volume dealing with a group of freshwater plants (including Flagellata); the volumes vary in size and price, but those so far published are remarkably low-priced, considering the abundant illustrations. Each volume is written by a specialist on the group dealt with, and a prospectus may be obtained through booksellers or direct from G. Fischer's Verlagsbuchhandlung, Jena. Of the volumes now obtainable Heft 1 deals with the colourless and Heft 2 with the coloured flagellate groups, which are of such great importance in connection with the evolution of the Algae; Heft 3 with the Peridineae, which some regard as of flagellate nature, and others as being definitely plants; Heft 6 with part of the Green Algae (Ulotrichales, Microsporales, Oedogoniales); Heft 9 with the Zygnemales (Conjugatae, excluding Desmids, which will form a separate volume); Heft 10 with the Diatoms; and Heft 14 with the Mosses and Liverworts. Subsequent volumes will not only complete the Algal groups, but also deal with the Pteridophytes and Seed Plants, and with the Plankton forms. This work is of great importance to British students of aquatic plant life, since very many of our species occur in the area to which this work is devoted—Germany, Austria, and Switzerland. Practically all the figures have been drawn specially for the work, every species being figured, while the general introduction to each volume and the details given regarding the morphology, development, biology, and methods of investigation and preparation make the work interesting and helpful to the amateur as well as a valuable reference book for more advanced students of botany.

PRUSSIC ACID IN PLANTS.—It has been known for some time that various plants, belonging to different families, produce free prussic acid. In these "cyanogenetic" plants the largest amount of this acid is produced by the green leaves and the young parts, while the root gives little or none. Animals rarely touch these plants. Light and the assimilation processes depending upon light exert a favourable influence on cyanogenesis, while the absence of carbon dioxide greatly diminishes the amount produced. According to Jorissen (*Bull. Acad. Roy. Belg.*, 1913), the most recent investigator of the subject, this acid may result not only from the process of carbon assimilation, but also from the action of nitrogen compounds upon substances like vanillin and citric acid. For instance, if a mixture of citric acid with a much smaller amount of potassium nitrite and a trace of bicarbonate of iron be exposed to light in a glass vessel for a day, the latter being open and kept at the ordinary temperature, hydrocyanic acid is formed. Citric acid is widely distributed among plants, and has been shown to be formed at the expense of sugar in cultures of lower fungi. The experiment described appears to represent pretty accurately what actually happens in plant tissues, and it is interesting to note that along with the prussic acid there is formed in the experiment the substance dimethylacetone, which is one of the products of polymerisation or doubling of the glucoside linamarine, also found in plants.

THE ALGAL GENUS *PORPHYRIDIUM*.—In 1849 Nägeli described, under the name *Porphyridium cruentum*, a common alga, which forms a thin slimy substratum of dark-red colour on damp ground, damp walls, and so on. The cells are closely arranged to form a thin gelatinous layer, and are either globular or angular by compression; the layer is several cells deep, the cell-contents are of a reddish purple colour, and cell-division takes place in all directions. The plant was at first placed in the Green Algae (Chlorophyceae), but Hansgirg, and also West ("British Freshwater Algae," page 351), considered it belonged to the Blue-green Algae, West remarking that there are many of the latter which possess as much red or purple pigment as *Porphyridium*, and that this genus is generally found in association with blue-green algae, and being, in his opinion, more nearly allied to *Aphanocapsa* than any other genus of algae. On the other hand, Gaidukov, in 1899, found that the red pigment of *Porphyridium* is very similar to the characteristic pigment (phycoerythrin) of the Red Algae in spectroscopic characters, and he suggested its being placed in the Bangiaceae, the lowest division of this group of algae. The same conclusion was arrived at by Brand in 1908, and adopted by Wille in Engler and Prantl's "Natürliche Pflanzenfamilien." The plant has again been investigated by Kufferath (*Bull. Soc. Roy. Bot. Belg.*, 1913), using the methods of isolation and cultivation employed in bacteriology, which have given such interesting and valuable results with the lower algae, growing the plant on gelatine containing the essential inorganic salts. The algae can assimilate certain organic compounds, of which the most favourable to its development are oxalate of lime, the sugar mannite, citrate of lime, and asparagin. Kufferath shows that the cells have no pyrenoid; what was formerly taken for one is simply an optical effect produced by convergence of the light-rays in the centre of the cell. He agrees with Hansgirg and Brand that from its morphological characters and the nature of the red pigment the genus should be placed

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in the lower Red Algae, and has no affinities with either green or blue-green algae.

EVOLUTION OF SIEVE TUBES.—Under this title Hemenway (*Bot. Gaz.*, Vol. 55)) gives the results of the study of the phloëm of one hundred and forty genera of Dicotyledons. He groups sieve tubes in three classes: (1) With a long, tapering end-wall, and the lateral and terminal sieve plates alike; (2) with end-walls less oblique, and the lateral sieve plates less well developed; (3) with end-walls nearly at right angles to the length of the tube, and a single sieve plate on the end-wall. The lists show that the woody Dicotyledons are found in the first of these classes, which is also the type of Conifers, while the herbaceous Dicotyledons occur either in the third class or between the second and third. These facts add to the evidence for the view that herbaceous Dicotyledons have been derived from woody plants. Striking evidence for this view—that trees and shrubs are primitive as compared with herbs among flowering plants—has already been obtained from the study of various other structures, including that of seedlings.

DICOTYLEDONS WITH ONE OR SEVERAL COTYLEDONS.—It has long been known that certain Dicotyledonous plants have a single cotyledon, while others have more than two, and that such cases may occur either normally or as accidental monstrosities. Compton (*Ann. Bot.*, Vol. 27) has investigated a considerable number of these cases, his paper being divided into two parts dealing respectively with Syncotyly (the two cotyledons "fused" into one) and Schizocotyly (the cotyledons "split" so that more than two are present in the embryo). In certain cases (*Swainsonia*, Sunflower, and so on) the anatomy of normal and syncotylous seedlings is compared; in *Swainsonia* the lateral union of the cotyledons produces practically no modification in the vascular bundle system, while in the Sunflower, syncotyly leads to elimination and compression of the bundles, together with reduction in the symmetry of the root-structure. In the case of lesser celandine the author considers the so-called syncotylous seed-leaf to be really a single cotyledon, the second one being suppressed. As to syncotyly in general, he shows that: (1) Syncotyly occurs in a large number of species, normally or teratologically; (2) in species with albuminous seeds syncotyly usually gives rise to a symmetrical cotyledon tube, the reason being probably the homogeneity of the surroundings of the embryo before germination; (3) in species with exalbuminous seeds syncotyly is usually asymmetrical, the cotyledons uniting along one edge only, the asymmetry of the environment producing accumbency and other irregularities as well. The author's main conclusion is that dicotyly is a primitive character, whether for Monocotyledons, for teratological, syncotylous, and schizocotylous Dicotyledons, for polycotylous Proteaceae and Loranthaceae, and for Gymnosperms.

CHEMISTRY.

By C. AINSWORTH MITCHELL, B.A. (OXON), F.I.C.

ESTIMATION OF THE DUST FALL NEAR CEMENT WORKS.—Of recent years the question of the amount of the dust fall in the vicinity of cement works has become very important owing to the legal actions brought by those in the neighbourhood against the manufacturers. The investigation of Mr. J. P. Mitchell (*Journ. Ind. Eng. Chem.*, 1914, VI, 454) of the various methods suggested for the estimation of dust in the atmosphere is therefore of value from many points of view.

Filtration methods, in which a given volume of air is aspirated through a filter, and the deposit of dust subsequently weighed, are not applicable to the purpose in question, which is to measure the amount of dust deposited in a given place. For the latter purpose satisfactory results were obtained by exposing glass plates smeared with vaseline for periods of three to five days at intervals over a length of time, such as three to five weeks. The plates were laid on horizontal platforms at the top of high poles, and care was taken to choose days on which there was little or no wind.

After the exposure the vaseline and adhering dust were removed from the plates by means of petroleum spirit, and the dust collected on a filter, which was then ignited and the residue weighed and expressed as "pounds per acre per day."

The total amount of dust thus collected was composed of the "field dust" blown from the surface of the ground, and normally present in the air, and the "cement dust" from the works. The former usually contained much silica and little calcium, while the latter contained a large amount of calcium salts and relatively little silica. Hence, by estimating the proportions of these ingredients it was possible to calculate with approximate accuracy the amount of "cement dust" deposited upon the plate. The following results are typical of those obtained in the vicinity of a cement works:—

Distance from Works. Miles.	No. of Plates.	Time of Exposure. Days.	Pounds per Acre per Day.	Silica per Cent.	Calcium Oxide per Cent.	Calculated per Acre per Day. Cement Dust.	Pounds per Day. Field Dust.
1·2	10	3·69	10·9	17·92	47·95	10·4	0·5
1·7	10	3·69	5·8	19·59	43·19	4·9	0·9
2·2	10	3·77	0·7	34·86	31·09	0·4	0·3

Possible errors, due to cement dust already in the soil, and blown on to the plates, could not be eliminated; but they were minimised by placing the plates at points remote from dusty roads. The effect of gusts of wind upon the deposition of the dust is shown in the following results:—

	Exposure Days.	Pounds per Acre per Day.	Silica per Cent.	Calcium Oxide per Cent.	Calculated Cement Dust per Cent.	Calculated per Acre per Day. Cement Dust.	Pounds per Day. Field Dust.
Normal	2·9	6·8	29·9	33·7	65·0	4·4	2·4
Windy	2·9	11·7	45·0	19·2	36·8	4·3	7·4

It would thus appear that the method is capable of estimating the fall of cement dust in excess of the normal fall of "field dust," for, in spite of the interference of the wind, the amounts of the former were practically the same throughout the two periods.

Interesting figures are given to show the dust fall near cement works in comparison with the recorded amounts deposited in great dust storms, the results in each case being stated in pounds per acre per day:—

Date.	Place.	Weight of Dust.
1846	South-eastern France	5·62
1847	Tyrol	17·80
1859	Westphalia	275·0
1862	Salzburg	0·75
1901	(March 9–12) Europe, maximum ...	32·4
	do. do. minimum ...	3·02
1912	California, vicinity of cement works, maximum	22·9
1913	California, vicinity of cement works, minimum	0·42

By suitable modifications of the plant practically the whole of this loss of cement could be eliminated, and it is stated that over fifty tons of dust per day have been recovered from one cement works in a form suitable for making into cement.

PLANTS AND CARBON DIOXIDE.—An interesting discovery has recently been made by Messrs. Klein and Reinau (*Chem. Zeit.*, 1914, XXXVIII, 545), whose experiments have shown that plants do not obtain a full supply of carbon dioxide from the atmosphere. They found that by supplying the plant with a large excess of carbon dioxide its growth was promoted to a pronounced extent. For example, plants grown for seven weeks in air containing 3·5 to 4·5 parts of carbon dioxide per thousand increased in growth from 124 to 238 per cent., as compared with plants grown in an ordinary atmosphere.

Referring to these experiments, Dr. Plaschke points out (*Chem. Zeit.*, 1914, XXXVIII, 804) that the moisture in the layers of soil from which the plant draws its nutriment must play an important part in the process, since it must absorb and retain the carbon dioxide formed in the rotting of the humus substances, and prevent its escape into the atmosphere, and thus being lost to the plant. In like manner, the dew, deposited upon the surface of the ground at night—the period during which plants exhale carbon dioxide—must prevent much of this carbonic acid from being permanently lost to the plant. In the daytime this moisture, impregnated with carbon dioxide, is taken up by the plant again.

In this connection it is of interest to note that these conclusions are contrary to the views expressed by Liebig, who held that the carbon dioxide exhaled by plants at night was derived from the moisture in the soil. This moisture was saturated with carbon dioxide, which, in the absence of sunlight, the plant was unable to assimilate, and therefore exhaled. Hence, in Liebig's opinion, this exhalation of carbon dioxide had no connection with the assimilation processes of the plant, and was due, not to physiological, but to purely mechanical causes. Careful experimental work would be necessary to prove or disprove the correctness of Liebig's mechanical theory.

ENGINEERING AND METALLURGICAL.

By T. STENHOUSE, B.Sc., A.R.S.M., F.I.C.

LIQUID AIR.—The perfecting of the apparatus for producing liquid air on the commercial scale has resulted in recent years in an increasingly greater amount being produced for the manufacture of nitrogen and oxygen, with the result that these substances have become increasingly cheaper, and new applications have been found for them. In a lecture delivered before the Société des Ingénieurs Civils de France, M. Georges Claude gave some interesting details of the present position of the liquid-air industry, the magnitude of which is indicated by the statement that "Cailletet's fleeting mist is to-day transformed into a fantastic river of liquid air, flowing at the rate of nearly one hundred thousand litres an hour." The air, after liquefaction, is fractionated, in order to separate the more volatile nitrogen from the oxygen. The heat required for vaporisation is supplied by fresh air destined to be liquefied; and to such a pitch of efficiency has the apparatus been brought that in evaporating thirty parts of liquid air more than twenty-nine parts of gaseous air are brought into the liquid state. In speaking of the more recent applications of oxygen, following on its greater cheapness, M. Claude described how thick steel plates can be cut with ease by a fine stream of oxygen playing on the metal, first heated to redness, and the advantages obtained by enriching with oxygen the air-blast in blast-furnace practice. A more novel application of oxygen is its employment in the liquid state as a constituent of an explosive. Lamp-black saturated with liquid oxygen burns slowly when ignited, but explodes violently when detonated by a fulminate primer. The advantages claimed for the new explosive are: (1) that as it is prepared immediately before use there are no transport dangers, and (2) in the case of misfires the evaporation of the oxygen causes the unfired cartridge to return quickly to a perfectly harmless state. The employment of the other main constituent of air (nitrogen) in the manufacture of cyanamide, and so on, has been described in a previous note.

SURFACE COMBUSTION.—The principle that the components of explosive gaseous mixtures will combine without flame, and at temperatures below the ignition points, when in contact with incandescent solids has been applied by Professor W. A. Bone and Mr. C. D. McCourt in the design of furnaces for commercial purposes. The success of these furnaces is due to the greatly accelerated rate of combustion produced by the incandescent solid and to the large amount of radiant energy developed, resulting in a very rapid transmission of heat from the seat of combustion to the object to be heated. One form of furnace consists of a porous diaphragm of refractory material through which a homogeneous mixture of gas and air is allowed to flow under slight pressure from a small mixing chamber. The diaphragm is composed of granules of fire-brick, or other material, bound together by suitable means into a coherent block. With such a diaphragm the actual combustion is confined within a very thin layer—one-eighth to one quarter inch only—immediately below the surface, and in no way depends upon the external atmosphere. When once the diaphragm has become incandescent, and the proportion of air and gas supplied to the mixing chamber at the back has been properly adjusted, the surface will maintain its incandescence unimpaired, even in an atmosphere of carbon dioxide. The temperature depends merely on the rate of feeding of the gaseous mixture, and as there is practically no lag in the temperature response, an extremely fine regulation of heat is obtainable. A second process, applicable to all kinds of gaseous or vaporised fuels, consists essentially in injecting, through a suitable orifice, at a speed greater than the velocity of back firing, an explosive mixture of gas (or vapour) and air in their combining proportions into a bed of incandescent, granular, refractory material, which is disposed around or in proximity to the body to be heated. It is claimed that by means of this process much higher temperatures are attainable with a given gas than by the ordinary methods of flame combustion without a regenerative system. For steam raising, the granules of refractory material are packed in steel tubes, which are surrounded by the boiler water. A steam trial of a 110-tube "Bonecourt" boiler gave a ratio of "heat utilised" to "net heat supplied" of 0·927.

GEOGRAPHY.

By A. STEVENS, M.A., B.Sc.

GEOGRAPHICAL RESEARCH.—The summary of the work of the Royal Geographical Society contained in the retiring address of the President, Earl Curzon of Kedleston, makes interesting and suggestive reading. During his three years of office exploration has been pursued with zeal and success. The discovery of the South Pole has removed from the competition the last of the trophies the pursuit of which appeals to the imagination of "the man in the street." Increasing attention will now be devoted by the explorer and the public to work, no less useful and difficult, in the frozen and other regions which has hitherto been less thought of. There are numerous unknown and insufficiently known parts of the globe to provide problems for years to come. "When," as the address runs, "an ex-President of the United States can plunge into the unknown, and return with a river a thousand miles long, so to speak, in his pocket, there is material to satisfy the most jaded appetite." More interesting still, however, is the reference to the need to provide suggestions and guidance in research for those geographers who cannot travel. The subject of geography has of late years received more and more attention in the schools and universities, and there is an increasing number of young men available whose interest and training might be put to account in studying the mass of material collected already. The mass will grow with increasing rapidity, and sooner or later the work of exploration will suffer from want of completeness and coördination in the information available.

GEOLOGY.

By G. W. TYRRELL, A.R.C.Sc., F.G.S.

GENETIC CLASSIFICATION OF ROCKS.—A most complete and logical classification of rocks on a genetic basis is given in Professor Grabau's new "Principles of Stratigraphy"—a monumental work in more than one sense, since it runs to one thousand one hundred and eighty-three pages and weighs five and three-quarter pounds.

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Professor Grabau does not recognise a primary distinction between igneous, sedimentary, and metamorphic rocks, but treats the whole rock field as falling into two grand divisions—the Endogenetic and the Exogenetic. The Endogenetic rocks are those formed by agents acting from within, that is, by agents intimately associated with the forming rock-mass. They include rocks formed by solidification, precipitation, or extraction of mineral matter from the states of igneous fusion, aqueous solution, or vaporisation. The Exogenetic rocks, on the other hand, are formed by agents acting from without upon already existing rock-matter. They are, in fact, the true clastic rocks, whereas the Endogenetic rocks are the non-clastic.

The Endogenetic rocks are subdivided into (1) Pyrogenic or igneous rocks; (2) Atmogenic rocks, due to precipitation from the atmosphere, *e.g.*, snow and snow-ice; (3) Hydrogenic rocks, due to precipitation from water, and almost wholly of chemical origin, *e.g.*, chemically formed limestones, siliceous sinters, salts, and so on; and (4) Biogenic rocks, due directly to the physiological activities of organisms, *e.g.*, coral limestones, coals, etc.

The Exogenetic rocks are classified primarily by reference to the agents responsible for their present characteristics. The texture, or rather grain-size, and lastly the composition, is then considered. Six principal groups are recognised, as follows:—

(1) Pyroclastic rocks—due to volcanic agencies, *e.g.*, tuff, agglomerate, volcanic breccia.
(2) Autoclastic rocks—including all rocks shattered or crushed within the crust by earth-movements, *e.g.*, fault-breccias and crush-zones. Glacial tills are also included here, since they are regarded as having been ground up between moving ice (treated as a rock) and the rock-floor on which it moves.
(3) Atmoclastic rocks—comprising rocks broken *in situ*, either by chemical or mechanical means, and re-cemented without further reärrangement by wind or water, *e.g.*, talus-breccias, arkoses, and consolidated decomposition products, such as laterite.
(4) Anemoclastic rocks—including the deposits laid by the agency of wind, *e.g.*, dune and desert sands and sandstones, loess, and so on.
(5) Hydroclastic rocks—the water-laid deposits, which include by far the greater number of the commoner types of clastic rocks, conglomerate, sandstone, and shale.
(6) Bioclastic rocks—types which owe their essential characters to the agency of organisms. In this class are included ant-mounds, soil due to earthworms, and such artificial products as bricks, plaster, concrete, and cement, for which man is responsible, and which at the present time form "rocks" of quite appreciable importance. The inclusion of the last group shows the degree of completeness of this classification.

The clastic rocks are also distinguished as *rudytes* (=rubble-rocks) when the grain is larger than that of sand-grains; as *arenytes* (=sand-rocks) when the grain is similar to that of ordinary sandstone; and as *lutytes* (=mud-rocks) when the grain is that of impalpable powder, or rock-flour. The size of grain is directly proportional to the intensity of the agent concerned in the production of the rock.

The composition of clastic rocks is frequently complex, but Professor Grabau gives two dominant types, the siliceous and the calcareous. Terms, such as "argillaceous," "ferruginous," "carbonaceous," are also used in the nomenclature. In describing both texture and composition, it is recognised that the various classes frequently pass one into the other by insensible gradations, and that it may be difficult or impossible correctly to designate certain complex intermediate types.

On the basis of the foregoing classification a nomenclature has been devised, the leading features of which will be seen from a few examples. When the composition is complex, reference to the composition is omitted in the name. For example, a *hydro-rudyte* is a water-laid conglomerate of complex composition; and a loess, the composition of which is generally very complex, is called an *anemo-lutyte*, in reference to its wind-laid character and dust-like grain. A pure quartz conglomerate deposited in water would be called a *hydro-silici-rudyte*; a consolidated dune composed of calcareous fragments of sand-grain size would be called an *anemo-calcarenyte*.

Once the reader gets over the strangeness of these formidable-looking compounds, it is easy to see that they form a very simple and concise description of the rocks to which they are applied, and, therefore, fulfil the purpose of a scientific nomenclature. Since the igneous rocks occupy quite a subordinate position in a logical arrangement of rock-types in general, the above scheme is mainly concerned with what are generally called the sedimentary rocks, and to many geologists it will provide a complete and satisfying classification of these rocks. The metamorphic rocks, according to Professor Graham, are most logically classified along with the rocks from which they have been derived.

METEOROLOGY.

By WILLIAM MARRIOTT, F.R.MET.SOC.

METEOROLOGICAL CONFERENCE AT EDINBURGH.—It was mentioned in the March number of "KNOWLEDGE" that it was proposed to hold a Conference of Observers and Students of Meteorology and Allied Subjects at Edinburgh from September 7th to 12th. The Executive Committee had made all the arrangements for a very interesting and successful gathering, but, owing to the sudden outbreak of war, they have felt obliged to postpone the Conference.

HOLIDAY WEATHER AT SOUTHPORT.—Mr. Joseph Baxendell, the Meteorologist to the Southport Corporation, in his Report for 1913, points out that the fineness of August last year is not a very frequent occurrence. All things considered, July is absolutely the best month of the year for outdoor holiday life at Southport, while both May and June are much drier, and also distinctly calmer and more sunny, than August. The earlier taking of holidays by some of the Lancashire and other towns is therefore very desirable. In any difficulty, September may be considered; in that district it is commonly a more settled month than August. Owing to the interesting and invaluable local daytime sea breezes, all the summer months are cool by day at Southport; but August is perhaps less bracing than any of the others.

ST. SWITHIN'S DAY AND SUBSEQUENT WEATHER.—The most popular of weather sayings is that relating to St. Swithin's Day (July 15th), for if it rain on that day, it is said that "St. Swithin is christening the apples." There is also the old superstition that it will rain more or less for forty days. The popular form of this saying is:—

"St. Swithin's Day if thou dost rain,
For forty days it will remain;
St. Swithin's Day if thou be fair,
For forty days 'twill rain nae mair."

From an examination of the daily records of rainfall in London for the past hundred years, it appears that the average number of rain days (that is, when ·01 inch has been measured) during the forty-day period, July 15th to August 23rd, is 15·7. During the hundred years there have been thirty-two occasions on which rain fell on July 15th (St. Swithin's Day), when the average number of rain days following was 17·3. There were sixty-eight occasions on which no rain fell on July 15th, when the average number of succeeding wet days was 14·9. This shows that on the average, when rain fell on St. Swithin's Day, there were nearly two and a half more wet days during the succeeding forty than there were when fine weather occurred on that day. But there is no foundation for the statement that it will rain for forty days, there being no case during the past hundred years, the nearest approaches being thirty-one

days in 1817, when it was wet, and thirty days in 1848, when it was fine on St. Swithin's Day.

The greatest number of consecutive wet days was nineteen in 1848, when St. Swithin's Day was fine, and the greatest number of consecutive days without rain (dry days) was twenty-seven in 1818.

The curve of mean temperature shows that on the average this is the hottest period of the year, and that fine, warm weather is probable for several weeks. If, however, rain fall for several days about July 15th, it indicates that the normal conditions have been deranged by cyclonic disturbances, and so rainy or broken weather may prevail for some time.

REMARKABLE SANDSTORM AT TULIA, TEXAS.—Mr. L. Mulhall, the U.S. Weather Bureau Observer at Tulia, Texas, reports that on March 18th a strong wind, which raised much dust and sand, was blowing from the west until 4.30 p.m., when it became calm and sultry, with the temperature about eighty-three degrees. The sky at the time was clear, except that a greyish bank of clouds or dust could be seen rising rapidly in the north. As it came nearer, it was found to be composed of several spiral columns, apparently five feet in diameter, and towering vertically upward to a height of three-quarters to one mile from the ground to the apex of the cloud. The phenomenon was beautiful and awe-inspiring beyond description, and the effect was heightened by the rays of the sun reflecting from the storm cloud. It was travelling at the rate of probably forty miles per hour, and about the time it crossed the Paledora Cañon there were two distinct flashes of lightning and two peals of thunder. There was no rain attending the phenomenon. The storm struck Tulia at 6.42 p.m., suddenly enshrouding the town in darkness and covering everything with dust and dirt. Wheat and oats were badly blown away, and several windmills blown down, while at Happy, about fourteen miles north, the Catholic church and several small houses and windmills were wrecked. The oldest inhabitants consider it the worst storm in the last twenty-three years.

MICROSCOPY.

By F. R. M. S.

A RARE FRESHWATER MITE (*Momonia falcipalpis* Halb.).—In the *Annals and Magazine of Natural History* (July, 1906) Mr. J. N. Halbert published a description and figures of a new Hydrachnid of the family Hygrobatidae which was found in Looscaunagh Lough in 1905. Two specimens only were taken, and, so far as I am aware, this was the only time until this year it has ever been found. As it is a mite about which we want to know more, it will perhaps be interesting to give a brief description and figure of it.

In June last Mr. Alabaster, of Plymouth, a gentleman who is gradually working up a list of the Hydracarina of that district, took, in Conn Quarry, a single specimen of this mite, which was new to him. This was sent on to me to identify. Not having seen one before, I had some little trouble with it myself, as the most striking feature of this mite—the peculiar modification of the first leg—was not figured. Mr. Halbert figured only the claw, not the penultimate segment.

The body is egg-shaped, the smaller end being to the front. It is very like *Midea orbiculata* on the dorsal surface, having the sunk line near the margin all round the body. It is about 0·72 millimetre long. Within the sunk line or groove there are two plates in the dorsal surface, the smaller one holding the eyes on the anterior portion of the body. Within the groove are several glands with hairs. The larger plate is decorated very strongly with a bright yellow Malpighian vessel. The actual colour of the skin is a dark-greenish yellow, but the body portion inside is very dark red and black, which makes the only light portion, the Malpighian vessel, stand out in very strong relief. The ventral surface is nearly all covered with the epimera, which runs back nearly to the posterior margin, leaving a bay for the genital area. The legs are about the same as we usually find on the Water Mites, except the front leg, which has the peculiar modification best shown by Figure 327c.

"Mr. Halbert says two fully developed examples of this species were found amongst a thick growth of Callitriche in Looscaunagh Lough, . . . and from the peculiar modification of the first pair of legs there is no doubt that the specimens are males." In nearly all the Water Mites it is in the male only that there is any modification in any of the legs. The females do not show this peculiarity, species of the genus *Megapus* being the exception. So Mr. Halbert may be right in saying his specimens are males for that reason. But the specimen Mr. Alabaster has sent to me also has the modified first leg, and it is a female, being full

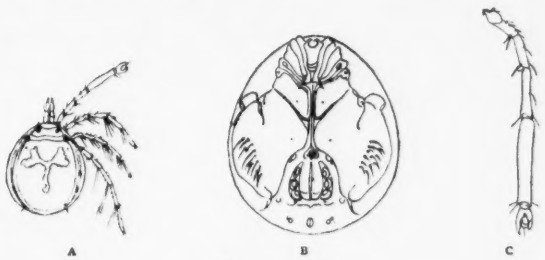


FIGURE 327.

of well-developed eggs. It is partly for this reason that we want to know more about it, and have more specimens to study; and, of course, the larval form and life-history are also unknown to us. Mr. Halbert gives it the specific name *falcipalpis* on account of the shape of the terminal palp-segment. Mr. Alabaster has paid several visits to the pond at Conn Quarry, but no other specimen has come to hand.

The Figure has been drawn from Mr. Alabaster's specimen.

A. Dorsal surface, showing the two plates.
B. Ventral surface.
C. First leg.

CHAS. D. SOAR, F.L.S., F.R.M.S.

THE QUEKETT MICROSCOPICAL CLUB.—The five hundredth Ordinary Meeting of the Club was held on Tuesday, June 23rd, 1914, Dr. E. J. Spitta, F.R.M.S. (Vice-President), in the Chair. After the usual business of an ordinary meeting, Mr. W. E. Watson Baker read a short paper describing in some detail a series of sections of fossils from the Coal Measures. These were not only rare, but were unique in the distinct manner in which they showed the various structures, both of plants and animals. They were exhibited under a number of microscopes, lent and arranged for the occasion by Messrs. Watson & Son. There were on view also whole specimens, still attached to the blocks of mineral in which they were found. The Chairman commented on the excellence of the exhibit, in conjunction with Mr. Watson Baker's description, and proposed a vote of thanks, which was heartily accorded.

The Honorary Secretary had received congratulatory letters on the Club's attaining its five hundredth ordinary meeting, with wishes for its continued prosperity and increase from Dr. M. C. Cooke, Dr. Karop, Mr. E. M. Nelson, Mr. A. D. Michael, Mr. Alphaeus Smith, and others: portions of these were read to the meeting; and on the motion of the Chairman a letter in reply to that of Dr. Cooke, who was one of the founders of the Club, and would be shortly reaching his ninetieth year, was ordered to be written on behalf of the members.

Dr. Spitta then, in celebration of the occasion, gave a short *résumé* of the history of the Club, with notices of many of those who had been foremost in its origin and work, and recounting various incidents and occurrences in its career. Particular reference was made to Mr. R. T. Lewis, one of

the oldest members, who had been Honorary Reporter since November, 1866, and was still able to carry out the duties of the office. He had attended four hundred and eighty-six out of the five hundred meetings, and the omissions had chiefly taken place only this last winter, owing to illness and advancing years. Mr. Alphaeus Smith, elected in May, 1866, was Hon. Librarian for forty years, but was not now able to attend the meetings. Dr. Karop and Mr. Earland, former Honorary Secretaries, were mentioned, with a kindly reference to the value of their work to the Club. Dr. M. C. Cooke, Mr. J. Terry, Mr. T. H. Powell, and Mr. Millett all joined in 1865, and are still members. Dr. Spitta finished his interesting and delightfully humorous lecture by recounting a supposed reverie (in verse), in which he saw most of the present officers and members coming into a meeting, and detailed with delicate skill and good nature their hobbies and characteristics.

In response to the invitation of the Chairman, several old members who were present then made a few remarks, Messrs. Lewis, Powell, Enock, Earland, and Hilton testifying to their appreciation of and good wishes for the Club.

The Chairman then proposed a rhyming "toast," wishing "Long life to the Club," and at his request the members rose in a body, and with hearty cheers expressed their concurrence with the sentiment. To wind up, Dr. Spitta threw upon the screen a series of lantern views of natural objects nature-coloured. Many of the various flowers and insects were wonderful productions, the colours being beautifully soft and lifelike. At the close, all agreed that it had been a very successful and pleasant evening, and quite in accordance with the best traditions of the Club, which, in the past, on occasion knew how to subordinate the severely scientific to more social methods.

Unfortunately too late to be read at the meeting, a marconigram arrived from the late Honorary Secretary, Mr. W. B. Stokes, at Montreal: "Congratulations five hundredth meeting." (Signed) STOKES.

J. B.

II.—THE COMMON GNAT (*continued from page* 313).—The areas between the nervures have, at regular intervals, short, thick projecting hairs, or processes: these resemble those found on the wing of the House Fly and the Blow Fly (see Figure 328). It is supposed that the hairs act as holders of air, and thus give the insect additional buoyancy. Just behind the point of attachment of the wings with the body, one on each side, are short club-shaped processes known as "halteres": these are supposed to be remainders of aborted wings.

These halteres, or balancers, as they are sometimes termed, are found in all insects belonging to the great order of Diptera, and in some they are very conspicuous, especially the Crane Fly (*Tipula oleraceae*) (see Figure 329).

The legs and feet of the Gnat are, like the wings, very delicate and beautiful in structure, the length of the legs is very great in proportion to the body, and each leg is made up of long-jointed segments having on each segment clusters of short hairs, very much resembling fins or wings when seen at the edge view (see Figure 330). At the tip of each leg is the foot, which consists of two claws, equal in size, which work on powerful muscles. The claws are unjointed; the familiar pads for adhering to rough or smooth surfaces, found in the House Fly, are absent; and this possibly explains why the Gnat is hardly ever found on window panes.

The insects commonly found during the summer months hanging themselves against our windows and fanlights over doors are very often mistaken for Gnats: they are similar in appearance to the naked eye, but a marked difference can be found in examining how they rest. The insect is known as the Harlequin Fly, or *Chironomus*, and, when resting, the fore legs are held up, not touching the surface upon which the other legs are in contact; whereas the Gnat raises its hind legs in a similar way, while the fore and middle legs touch the surface on which the insect rests.

The process of egg-laying by the Gnat (♀) is worth describing, and, when the period for this function approaches, the insect seeks out some pool, ditch, or some place where stagnant water is contained. The actual details have been so well described by Réaumur, of thermometer fame: "The Gnats supports her body, on the first and second pairs of legs, on some floating object, the third pair of legs or hind legs are then crossed, and in the angle between them the eggs are held as they pass out, one by one, from the tip of the abdomen (see Figure 331).

The whole operation of egg-laying takes place in the early hours of the day, and when complete the mass of eggs is released, forming a raft about a quarter of an inch long, and consists of from two hundred and fifty to three hundred cigar-shaped bodies, glued together, forming a concave-shaped boat. The egg, at its upper end, is pointed; thus a mass of them causes depressions to occur between each egg. When collected in this way, the lower end of the egg is provided with a lid, and through the opening of this lid, when turned back on its hinge, the larvae issue forth into the water when developed. The egg-raft cannot be swamped, and it cannot be made to sink, whatever means are adopted, whilst the eggs are together in a mass. The raft always floats on the surface of the water, and its buoyancy is remarkable.

The fact that the egg-raft never sinks, or is unsinkable, is due to the force of the surface-film of the water and its pull; also, the surface-film cannot penetrate between the eggs. Thus the depressions, or cavities between the eggs are always filled with air-bubbles, and this keeps out the water.

W. HAROLD S. CHEAVIN, F.R.M.S., F.E.S.

PHOTOGRAPHY.

By EDGAR SENIOR.

PYROGALLIC ACID OR "PYROGALLOL."—Although the amidophenols, "rodinal, amidol, and so on," have largely replaced pyro as a developer in the hands of amateurs, more especially in the development of instantaneous exposures, where rapidity is, as a rule, required, it is found that the professional photographer still employs pyro almost exclusively, and only resorts to other developers when speed is a desideratum, or in cases of known under-exposure. This preference is no doubt due to the readiness with which pyro developers may be adjusted to meet the requirements of any particular class of subject or plate, as, according to the amount of alkali used, it can be prepared to work rapidly and softly, or slowly and hard, while density can be increased to a degree which is practically unattainable with the new rapid developers. There can be no doubt that such developers as amidol develop more rapidly, but the action of pyro may be greatly accelerated by the addition of a larger quantity of alkali without risk of fogging the plate to the same extent as would be likely to occur if the same procedure were adopted with some of the other developers. Then, again, pyro can be kept in solution for a length of time by the simple addition of sodium sulphite, while it will still remain active at low temperatures. With these facts before us a short description of the chemical history of pyrogallic acid should not be without interest to those who practise the art of photography. The substance was first prepared by Scheele, the great Swedish chemist, by the action of heat upon gallic acid—a body of which he was also the discoverer. Scheele considered it to be simply sublimed gallic acid; the dissimilarity between the two bodies, however, which was pointed out by Leopold Gmelin and Braconnot, led the French chemist, Pélouze, to study its mode of formation from gallic acid, and to establish its true composition: he pointed out that when gallic acid was heated to 200° C. (392 F.) carbon dioxide was liberated, and a white sublimate

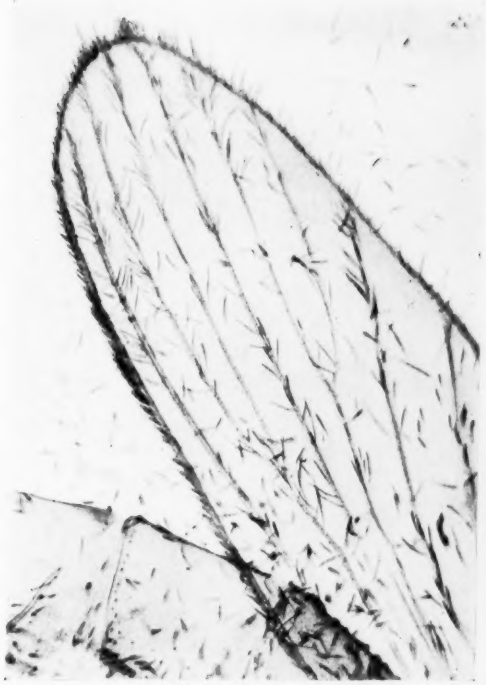


FIGURE 328.

Left Wing of the Gnat (*Culex pipiens*), ♀, showing nervures and processes between them with scales and hairs.

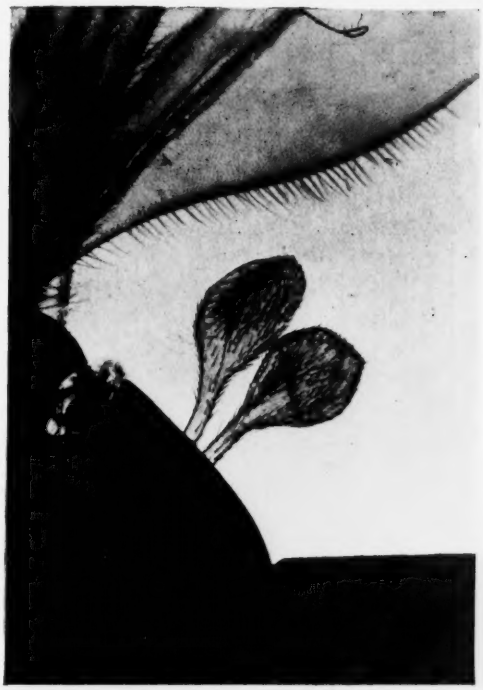


FIGURE 329.

Halteres, or Balancers, of the Crane-fly (*Tipula oleracea*).

FIGURE 330.

Leg and Foot of the Gnat, showing fringe of hairs and two claws at the tip.

FIGURE 331.

Eggs of the Gnat which have just been extruded.

XUM

FIGURE 332. The "prize mushroom" of Glacier House, a symmetrical snow-cap nine feet in diameter (see "Reviews").

FIGURE 333. Current-mark made during rain by a temporary stream on a sandy road, photographed after the road had dried (see "Reviews").

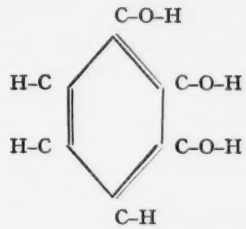
(From "Waves of Sand and Snow," by Dr. Vaughan Cornish. By the courtesy of Mr. T. Fisher Unwin.)

XUM

termed pyrogallic acid formed; a reäction which is expressed by the following equation:

$$C_6H_2(OH)_3COOH = C_6H_3(OH)_3 + CO_2$$
Gallic acid. Pyrogallol. Carbon dioxide.

Pyrogallic acid is a benzene derivative, being known as trihydroxybenzene, and having the following graphic formula:



It is a colourless crystalline substance, readily soluble in water, but if the temperature at which the reäction takes place rises much above 200° C. the substance is converted into a black, shining, non-crystalline mass, known as meta-gallic acid, which is insoluble in water, the change which gives rise to this taking place in accordance with the equation:

$$C_6H_3(OH)_3 = C_6H_2(OH)_2 + H_2O$$
Pyrogallol. Meta-gallic acid. Water.

If the temperature rises sufficiently high, the whole of the pyrogallic acid becomes decomposed. Hence the production of pyrogallic acid is dependent upon a comparatively narrow interval of temperature, which greatly adds to the difficulty of its preparation. This difficulty, however, may be overcome by heating the gallic acid with water to a temperature of 200° C. for about half an hour in a sealed vessel. The solution is then boiled with a little animal charcoal to decolorise it, after which it is evaporated to dryness, and the residue distilled under diminished pressure. By this method very nearly the theoretical yield of pyrogallic acid is obtained. Pyrogallic acid is not, strictly speaking, an acid at all, and its solution is not acid to test-paper, and in all recent works on chemistry it is called pyrogallol, for the same reason that carbolic acid, "whose properties are more those of an alcohol than an acid," is termed phenol. As every photographer is aware, an alkaline solution of pyrogallol rapidly becomes brown on exposure to air, due to absorption of oxygen. Many other substances, such as grape juice, extract of malt, and gum arabic, bring about the oxidation of pyrogallol in aqueous solution, the solution gradually acquiring a port-wine colour, and depositing crystals of a compound known as purpurogallin, having a formula $C_{18}H_{14}O_9$, which resemble alizarin in their appearance and in the colours which are imparted to mordanted fabrics. This compound is also formed by cautiously adding an alcoholic solution of silver nitrate and also by the oxidising action of potassium permanganate:

$$3C_6H_6O_3 + O_3 = C_{18}H_{14}O_9 + 2H_2O$$
Pyrogallol. Purpurogallin.

The action of a solution of potassium permanganate upon pyrogallol is also of interest as constituting the basis of a method for the volumetric determination of the value of various samples of pyrogallol; as a solution of permanganate of potassium dropped into one of pyrogallol, made acid with sulphuric acid, becomes instantly decolorised. The solution of pyro gradually acquires a port-wine colour, due to the formation of purpurogallin, as shown by the equation; and on the further addition of the permanganate the colour gradually changes to yellow, and finally disappears altogether, due to the complete oxidation of the purpurogallin to carbon dioxide and water:

$$C_{18}H_{14}O_9 + O_{54} = 18CO_2 + 7H_2O$$
Purpurogallin. Carbon dioxide. Water.

It should also be remembered that pyrogallol is poisonous, resembling that of phosphorus in its physiological action, exerting its power by reason of its great affinity for oxygen, which it is able to extract from the blood.

PHYSICS.

By J. H. VINCENT, M.A., D.Sc., A.R.C.Sc.

LIGHTNING.—In the issue of *Science* for July 17th, 1914, Prof. Cleveland Abbe appeals for information on this subject. The particular matters upon which further knowledge is sought by the head of the United States Weather Bureau are concerned with the oscillatory character of lightning. After referring to the work of Mayer and others on the subject, Professor Abbe concludes his letter by stating that he hopes "to receive responses from electricians and physicists whose experiments and experience tend to elucidate the subject." Many who read this letter will be struck on reflection by the limited state of our knowledge on the subject. In the elementary text-books various kinds of lightning are described: (1) The normal form, consisting of a spark discharge of electricity, represented by artists as a luminous zigzag line, and whose correct form is now well known through photographs. (2) Sheet lightning, which illuminates large areas without having any definite shape. (3) Summer lightning, which lights up a large portion of the sky at a time. (4) Globular lightning, which consists of moving balls of fire which are said to explode with a loud report. I am inclined to regard (1) as being by far the most usual type of discharge. (2) is said to be caused by brush discharges between clouds, but the appearance of sheet lightning may also be due to scattering of the light of a normal discharge by a cloud which lies in the observer's line of sight. Summer lightning is the general lighting up of a part of the sky, due to the scattering of light from very distant normal discharges. The extremely rare globular lightning is said to have been imitated in the laboratory. I know no one who has ever seen either the natural or the artificial form of globular lightning. It thus appears that the most important part of the problem is the investigation of the normal form of lightning discharge. Although thunderstorms do not occur in this country with excessive frequency, they are still frequent enough to make their study practicable. The subject is one which might very profitably be taken up by the amateur from the observational standpoint.

THE QUANTUM THEORY.—The Physical Society of London has issued a very valuable report, by Professor Jeans, on Radiation and the Quantum Theory. The author is one of the greatest living authorities on mathematical physics, and the report will be welcomed by many experimentalists who have been at a loss whither to turn for a connected account of this theory, which is now being used in several different branches of physics. The central idea of the Quantum theory is that when any form of radiant energy is being given out into space it is thrown out in distinct amounts or quanta, and not continuously. In other words, radiation of heat or light, or x-rays, is not a steady, continuous process, but is one in which the energy is liberated intermittently. The amount of each parcel of energy is, however, capable of variation, but is always proportional to the frequency of the wave-motion which is being radiated; so that if the amount of energy liberated at a time be called W, and the number of complete vibrations a second of the radiation be n, then

$$W = hn \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (i)$$

where h is a constant. This quantity h is not merely constant for the case of the particular thing which is giving out the radiation considered; it is a universal constant of nature, and is the same, no matter what is giving out the radiation, or what is its chemical or physical nature or condition. It is possible to evaluate in figures this quantity h (which is called Planck's Constant), the result being:

$$h = 6{\cdot}6 \times 10^{-27} \text{ ergs} \times \text{sec.} \quad . \quad . \quad . \quad . \quad . \quad (ii)$$

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The real nature and meaning of this constant are not yet known, though some light on the subject may be obtained from very elementary considerations. If equation (i) is true at all, then h must be of the physical nature of energy divided by frequency; that is, it must be of the dimensions of length squared, multiplied by mass and divided by time. These are the dimensions of angular momentum. So that one might regard the fundamental equation of the Quantum theory (equation i) as suggesting that the angular momenta of the radiating portions of an atom must necessarily have values equal to kh, or an exact multiple of kh, where k is a pure number of no physical dimensions. In my Physics Notes for August I referred to the method of calculation of line spectra by Dr. Bohr. The method can now be more clearly explained. Bohr's assumption is that the angular momentum of the electron in the atom is either $h/2\pi$ or an exact multiple of $h/2\pi$, or that k equals $1/2\pi$.

THE SPECIFIC HEAT OF SOLIDS.—One of the most interesting chapters in Professor Jeans' report is that dealing with recent theoretical and practical work on the specific heat of solids. For most elementary bodies the product of the specific heat and atomic weight is a constant. This statement, which has long been known as Dulong and Petit's Law, becomes more nearly exact as the temperature, at which the specific heat is found, is raised. The constant value of the product (called the atomic heat) becomes 5·95 after certain corrections have been applied to the experimental results. This value is in agreement with that obtained theoretically on the assumption that the atoms behave as mathematical points endowed with inertia. The atomic heat is, however, dependent on the temperature, and only reaches the above value at high temperatures, at lower temperatures it is less. At very low temperatures, indeed, the atomic heat is very small, and when a curve is drawn in which the atomic heat of a substance is plotted against the temperature, the shape of the curve implies that the atomic heat would be zero at the temperature of absolute zero (−273° C.). It is a very remarkable circumstance that the curve is of the same shape for all the elements, and that any one curve (say that for aluminium) can be made to fit on any other (say that for lead) by merely altering the scale of drawing for temperature. In his report, Professor Jeans goes on to explain how this follows from the Quantum theory, but is not in accord with the older and hitherto more orthodox views.

SPECTRUM OF γ-RAYS.—These rays are given out spontaneously by radio-active bodies. They are in general character similar to x-rays, but differ from them in being more penetrating. Since the discovery that crystals will act as diffraction gratings for x-rays, the same method of attack has been applied to the γ-rays. A paper on the spectrum of the penetrating γ-rays from Radium B and Radium C by Professor Sir Ernest Rutherford and Dr. Andrade appears in the *Philosophical Magazine* for August, in which the crystal reflection method is further developed by the measurement of absorption as well as reflection lines. In the course of the work the shortest waves known were measured and found to be 7×10^{-8} centimetres long. Light in the middle of the visible solar spectrum has a wave-length of 6000×10^{-8} centimetres, or about nine hundred times as great. This γ-ray, then, is in the ninth octave above that of ordinary yellow light.

ZOÖLOGY.

By PROFESSOR J. ARTHUR THOMSON, M.A., LL.D.

A HARDY WORM.—Casimir Cépède has studied the adaptability of an interesting Polychaete worm, *Nereïs* (*Hediste*) *diversicolor*, which lives in brackish water, in the sea, and in fresh water, and can accommodate itself even to briny conditions. As other naturalists have also pointed out, this Nereïd shows a great power of surviving even sudden changes in salinity.

SEQUENCE OF PLUMAGES IN A MALE TRAGOPAN.—C. W. Beebe, Curator of Birds to the New York Zoölogical Society, has published some very interesting preliminary notes of studies which he has been making on pheasants. Thus, in reference to the male of *Tragopan satyra* he finds the following suggestive sequence of plumages: (*a*) A down plumage of definite regional pattern; (*b*) a juvenile plumage of definitely patterned feathers; (*c*) a first winter's plumage of very generalised female-like coloration and (*d*) the adult plumage exceedingly specialised as to the feathers themselves and as to their distribution, colour, and pattern.

COMPLETE TOOTHLESSNESS OF MYRMECOPHAGIDAE.—It is well known that the members of this edentate family, of which the Great Ant-eater (Myrmecophaga) is a type, show no traces of teeth. This was satisfactorily proved by Röse and by Leche many years ago. It has been suggested, however, that the investigation of young embryos might result in the discovery of vestigial tooth-rudiments. It is interesting, therefore, to notice that Herr Adloff recently sectioned two embryos of the Little Ant-eater (*Cyclothurus didactylus*), six centimetres and twelve centimetres in length, and found no hint of either tooth-germs or a dental ridge. If there are any vestiges they must be in still younger embryos.

INFECTIOUS ALTRUISM.—In his observations on the breeding habits of the white ibis (*Guara alba*), Mr. C. W. Beebe refers to an interesting phenomenon indicated by the title of this note. Both parents take part in incubation and in feeding the young, and the male bird may feed his mate. The food consists of comminuted fish, which is collected in the chin sac. The old bird opens its bill widely when it comes to the nest, and the young ibis reaches up and takes the food from the throat of the parent. "The sight of this feeding process is contagious, and I have seen unmated ibises moved to fly up with offerings of food, and even the young bird of the preceding year makes similar attempts. All are hustled away by the parents, however, before they have even a chance to carry out their altruistic efforts."

ORIENTATION IN SWIMMING CRUSTACEANS.—W. v. Buddenbrock has made a number of ingenious experiments on shrimp-like Crustaceans with reference to their power of adjusting their position in the water. This seems to depend on three reflexes, which are frequently combined. Most important is the reflex associated with the eyes, the animals being thereby bound, if they can, to keep their dorsal surface exposed to the rays of light which normally come from above. Secondly, there is a gravitational reflex associated with the statocysts, the animals being thereby bound, if they can, to keep their ventral surface towards the centre of the earth. There is a third, more mysterious, reflex, which does not seem to be associated with any special sense-organ, but has to do with the general pose of the body.

MILLIPEDE'S NEST. — Mr. Hugh Main has watched the nest-building of a Common Millipede (*Polydesmus complanatus*), which is often found under stones and pieces of wood. The female swallows earth, and passes it out posteriorly, moulding it into a circular wall with the protrusible end of the alimentary canal and the anal flaps. She travels clockwise round the wall, and, after it is raised a little, deposits a layer of eggs within its shelter. Another layer of material is next added to the wall, then another layer of eggs, and so on alternately. As the wall is raised the diameter is reduced. A dome is almost formed, but the top is carried up into a vertical chimney. The whole structure is then disguised with minute pieces of earth, but a small opening shows the top of the chimney. When the eggs hatch the little white six-legged Millipedes climb up the chimney. They are long in assuming the usual dark colour (sometimes not for more than a year) and their full complement of legs.

REVIEWS.

ASTRONOMY.

Collated List of Lunar Formations, named or lettered in the maps of Neison, Schmidt, and Mädler.—Compiled and annotated for the Committee by Miss M. A. Blagg and the late S. A. Saunder. Edited and with an Introduction by Professor H. H. Turner. 182 pages. 10½-in. × 7-in.

(Oxford: The University Observatory. Price 2s. 6d., postage 3d.)

This work is one produced under the direction of the Lunar Nomenclature Committee of the International Association of Academies. It may be well to recall how this committee came into existence.

The late Mr. S. A. Saunder, for many years the Senior Mathematical Master at Wellington College, drew attention in 1905 to the extremely complex and unsatisfactory state of the nomenclature of the more important lunar formations. In concluding his paper he considered the matter could be satisfactorily solved only by some international committee. The international association of academies, formed in recent years, accepted the proposal when it was brought before that body at the meeting in Vienna in 1907. A lunar nomenclature committee of six was appointed, eventually three others were added, and the work was immediately taken in hand. Though so recently appointed, it is sad to think that all of the six but Dr. Weiss and Professor Turner are dead.

Until his death, Saunder was working hard upon this committee and this book, and by the invaluable aid of Miss Blagg in the collation of the List and in reading the proof sheets, the printing and publication have been achieved. But it is doubtful if so much would have been possible had it not been for the courteous help of the French Government, at the recommendation of the Académie des Sciences (Paris), in bearing the cost of the printing, Great Britain and Germany undertaking the cost of the maps. This list marks a decided step forward in lunar work. The list itself is only a preliminary one to that which it is intended or contemplated to publish when the Committee shall have decided upon the names or notation of about five thousand formations. The actual list consists of parallel columns for the names given by Neison, Schmidt, and Beer and Mädler, to which are added columns for the current number and the symbol. The explanation of the List and its collation is given on two pages. Altogether, there are four thousand seven hundred and eighty-nine formations noted on one hundred and sixty-eight pages, followed by ten pages of notes, and concluded with an index of four pages of the proper names. The work can be obtained from Oxford or Messrs. W. Wesley & Son, Essex Street, London.

F. A. B.

CHEMISTRY.

The Whole Art of Dying. 359 pages. 7½-in. × 5½-in.

(Shottery: The Tapestry Studio. Price 3/6.)

In the year 1705 an English translation from the French and German of the methods then used in "dying" silk, linen, and woollen fabrics appeared in London. It was a happy thought of the publishers of this book under consideration to unearth the old treatise, and to issue it in a form in keeping with the old spelling and phraseology.

The methods of dyeing fabrics then in use were purely empirical, but gave excellent results, for they embodied the experience of generations. In fact, many of the processes described here have only been superseded because they were too expensive for the present day.

Among the other subjects dealt with are the choice and cultivation of the plants that produce the dyestuffs, the use of chemicals to fix and brighten the colours, and the methods adopted in France to prevent the adulteration of dyes.

All who practise the craft of hand-loom weaving should welcome this little book, which will show them how to dye, while to chemists who have specialised in this subject it is of historic interest.

C. A. M.

Intermetallic Compounds.—By C. H. Desch, D.Sc., F.I.C. 116 pages. 9-in. × 6-in.

(Longmans, Green & Co. Price 3/- net.)

There was no subject more in need of a critical survey than the researches that have been made into the nature of the compounds formed between different metals. Hence this is a particularly useful addition to the series of "Monographs on Inorganic and Physical Chemistry," the object of which is to correlate the latest investigations in their particular field and to serve as a reference handbook to workers on the same ground.

Dr. Desch is well known as a writer on metallography, and in the present short monograph we find the critical attitude which ought to be shown by an authority on his subject. The historical part is, perhaps, dealt with somewhat too briefly, though this was possibly inevitable from considerations of space, seeing that the main object of the book is concerned with recent researches.

The subjects dealt with include Thermal Methods, Microscopic Structure, the Physical and Chemical Properties of Intermetallic Compounds, and their Relationship to the Compounds of the Metals with Carbon and Silicon. There is a good index and an excellent bibliography.

C. A. M.

Chemical Calculations. (Advanced Course.)—By H. W. Bausor, M.A. 48 pages. 7-in. × 5-in.

(W. B. Clive & Co. Price 1/-.)

This little book will be found of great use to students who are working by themselves for any of the more advanced examinations. The methods of calculations used in quantitative organic analysis, molecular-weight determinations, and thermo-chemistry are clearly explained, and illustrated by typical examples, and after each section problems are set, to be worked out by the student. Tables of logarithms, and other reference tables, are given at the end of the book.

C. A. M.

MEDICINE.

Black's Medical Dictionary.—By John D. Crombie, M.A., B.Sc., M.D., etc. 859 pages. 431 illustrations. 12 plates in colour. 5½-in. × 8½-in. 5th edition.

(A. & C. Black. Price 7/6 net.)

This book is evidently intended for the intelligent lay public. No knowledge is assumed, and everything is simply and clearly explained. No attempt is made to make the book sensational, but it is nevertheless easy to read and, above all things, correct. It may be said to be a compendium of the simpler facts of anatomy, physiology, medicine, and surgery; indeed, there is hardly any branch of the subjects, however modern, that is not at least touched upon. Every care has been taken to make the book of real use to those for whom it is written, and thus we find at the beginning two pages of special directions, telling us to what subjects to refer in cases of accidents of all sorts, and instructions where is to be found information regarding sanitation, personal hygiene, illnesses of children, and a host of other details of everyday importance.

Another very useful feature is a series of excellent coloured plates of the rashes peculiar to the commoner infectious diseases of childhood. We most strongly recommend the work to all who require simple, practical information in cases of emergency, for we feel that it would be impossible to collect a more useful series of medical facts in a book of the same size as the one we have before us.

S. H.

XUM

MINERALOGY.

Practical Instructions in the Search for, and the Determination of, the Useful Minerals, including the Rare Ores.—By ALEXANDER MCLEOD. 114 pages. 6½-in. × 4-in.

(Chapman & Hall. Price 5/6 net.)

This book aims to give very simple and easy means of identifying the useful minerals. Only very crude apparatus and a few inexpensive chemicals are needed. The author has drawn upon the prospecting experience of forty years in the preparation of this small book, and it is consequently packed full of time-saving hints and tips in the discovery and identification of useful minerals. It is shown that certain minerals are easily determinable by such simple means as a match flame, a burning pine sliver, or a live coal. Many tables are given, showing the simple eliminatory tests for various classes of minerals. An especially valuable feature is the prominence given to methods of identifying the rare ores. Recent industrial developments have sometimes made these ores more worth searching for than gold or silver. The author is optimistic in regard to the future of the prospector, as can be seen from the following picturesque quotation: "Who says the prospector's day hath fled? His day is now; and it is merely early morn. And the continents, practically unexplored, especially as far as the rare ores are concerned, invite him to their undiscovered bonanzas." This is an unconventional but thoroughly practical book which can be highly recommended to prospectors and miners.

G. W. T.

ORNITHOLOGY.

The Birds of North Hertfordshire. Being Notes on the Birds of Hitchin and Surrounding District of North Herts, with Table of Dates of Arrival of Summer Migrants since the year 1908.*—By ARTHUR H. FOSTER, with frontispiece plate and introduction by W. BICKERTON. 32 pages [n.d.]. 8-in. × 5-in.

(Hitchin: Paternoster & Hales. Price 2/-.)

This is a lengthy and most useful contribution to the avifauna of a county which still waits a complete history of its birds, one hundred and ninety-two species being recorded by Dr. Foster. Careful distributional details are given, particularly of the rarer and more interesting species, and the status of most is well and clearly indicated. In his legitimate enthusiasm sometimes the author stretches a point, as when he says that the Bearded Tit is a "very rare visitor indeed," basing this on one old record dating back to 1848. We think, too, that it would have been better to have included the records of "escapes"—the Crane, the African Crowned Crane, and the Canada Goose, also the domesticated Mute Swan—under a separate heading as Introductions.

Considering the non-maritime character of the country, there is a surprisingly long list of water- and sea-birds, such as waders (mostly occurring in passage), Gulls, Geese, and Ducks (visitors). This seems to suggest that a migration fly-line touches on the district. The Stone Curlew still continues to nest in at least one place, and a local photograph of the bird approaching its nest is given as a frontispiece. Of the diving sea-birds a rather unexpected result is stated in the remark that the Little Auk is probably the commonest to be reported. The table of summer migrants covers twenty-three species, and a full index concludes the work.

H. B. W.

(1) *Bulletin of the British Ornithologists' Club.*—Edited by W. R. OGILVIE-GRANT. Report on the Immigrations of Summer Residents in the Spring of 1912; also Notes on the Migratory Movements and Records received from Lighthouses and Light-vessels during the Autumn of 1911.—By the Committee Appointed by the British Ornithologists' Club. 335 pages. 19 maps. 8-in. × 5-in.

(Witherby & Co. Price 6/– net.)

(2) *Report on Scottish Ornithology in* 1912, *Including Migration.*—By LEONORA JEFFREY RINTOUL and EVELYN V. BAXTER. *The Scottish Naturalist* Extra Publication. 96 pages. 8-in. × 5-in.

(Edinburgh: Oliver & Boyd. London: Gurney & Jackson. Price 1/6 net.)

(3) *Aberdeen University Bird-migration Inquiry: First Interim Report* (1900–12).—By A. LANDSBOROUGH THOMSON. Reprinted from *The Scottish Naturalist*, July, August, October, and November, 1912; February, April, and June, 1913. 55 pages. 8-in. × 5-in. Privately issued.

The collection of material on the subject of bird migration in Britain proceeds apace, and the three works named above are substantial contributions thereto. The "Bulletin" is the eighth consecutive Annual Report issued by the British Ornithologists' Club, and follows the lines previously laid down. These reports contain a large amount of information, the value of which will be greatly increased when the whole series is summarised and reduced to order. The volume under notice contains details of the immigration movements of thirty-three of our summer visitants, and sketch-maps are given for several of the species. These species are mentioned again under other headings in the Report, and it would be an advantage if cross-references or an index were added. A long series of notes (pages 214–278) on autumn migratory movements is given, and these are perhaps more important than the reports on the arrival of summer birds as dealing with a less-known aspect of the subject.

The Scottish Report is an admirable piece of work, and nothing more thorough and clear has been published. Various phases of the subject are described under separate headings, such as Birds new to Scotland, Uncommon Visitors, Hybrids, Extension of Breeding Range, Food, Habits, and so on; but the bulk of the Report is taken up with notes on the movements of birds (pages 34–91). Some two hundred and four species are briefly dealt with in detail, forming a classified and consecutive record of great value, enhanced by the addition of an index of all the species, thus making each entry throughout the Report immediately accessible. The movements of birds in Scotland are certainly well accounted for in this work, which follows one of a similar character by the same authors for the previous year.

The Aberdeen University Report is more limited in scope, being an account of a piece of research work undertaken by the method of marking birds by ringing, and recording those recovered and satisfactorily identified. The recoveries are enumerated in detail under the separate species, many of the records, however, being so trivial as scarcely to justify publication. Very wisely, no attempt is made to draw conclusions at present, but results of value are anticipated from this well-organised and systematic piece of migrational work when it is completed.

H. B. W.

PHOTOGRAPHY.

Photography in Colours.—By GEORGE LINDSAY JOHNSON, M.A., M.D., B.S., F.R.G.S. 235 pages. 13 plates and numerous text illustrations. 7-in. × 5-in.

(George Routledge & Sons. Price 3/6 net.)

This work, which constitutes the second edition of this textbook, has been very carefully revised and brought up to date by the author, and gives a very complete account of the best-known processes of colour photography from both a theoretical and a practical aspect, together with a chapter explaining the latest theories regarding the nature

* 1898 is the correct date, as given in the table.

of light and colour. A short chapter is also devoted to the evolution of colour photography, while in another one the comparison between the eye and a camera and the retina with a colour plate is fully discussed. Then the spectrum sensitiveness of a photographic plate, as compared with the visual effect of the spectrum, is explained. The author then proceeds to describe the various methods which have been devised for obtaining photographs in colour, beginning with the interference method due to Professor Lippmann, and proceeding to the various screen-plate processes, such as the "Joly," "Lumière," "Omnicolore," "Dioptichrome," "The Thames Plate," and the "Paget," which are dependent upon the mixing of coloured lights, a principle which is explained in the following chapter. Chapter VIII is devoted to the practical working of single-colour screen plates, giving an account of the various defects that are likely to be met with, and the remedies for the same. Indoor portraiture by means of flashlight, increasing the sensitiveness of colour-screen plates, and the preparation of light-filters for colour photography also find a place in this chapter. In Chapter IX the various methods which involve the use of two and three plates are dealt with, both theoretically and practically, such as the triple-plate process of Sanger-Shepherd, Mr. E. T. Butler's triple-plate camera, and Ives' "Kromskop." Chapter X is devoted to various methods for obtaining colour prints upon paper, such as tricolour half-tone and collotype printing, Sanger-Shepherd's imbibition process, and Dr. E. König's "Pinatype" process, as well as those in which three-colour carbon tissue is employed. In Chapter XI a very full account is given of the latest method for producing colour-prints upon paper by the "bleach-out" process, employing "Uto" paper and a coloured transparency. The final chapter in the book, "Chapter XII," deals with kinematography in colour by means of coloured lights, giving a description of the apparatus employed in taking the pictures, and the various means in use for afterwards projecting them upon the screen. In the Appendix a short account will be found of various theories of colour-vision; tables giving the exposure for various subjects, with combined and separate colour plates, different developers, and the times of development, intensification, and reduction of autochromes and similar screen plates, and so on. In conclusion, we may say that the book will be found a most useful addition to the library of all interested in the subject of colour photography, and we strongly recommend it to the student who desires to gain a thorough knowledge of the theory and practice of the various processes of colour photography with which it deals.

E. S.

SOCIOLOGY.

Interpretations and Forecasts: A Study of Survivals and Tendencies in Contemporary Society.—By VICTOR BRANFORD, M.A., sometime Honorary Secretary of The Sociological Society. 424 pages. 8½-in. × 5½-in.

(Duckworth & Co. Price 7/6 net.)

This is a clearly written and suggestive book by a staunch disciple of Professor Geddes. It might well have borne as sub-title, "A Plea for the Study and Practical Application of Civics." At times, perhaps, the author's style seems a trifle affected, as though he were striving to say something smart, and the whole book leaves an impression of vagueness. He criticises socialism on the grounds that it shuts its eyes to everything but the economic order of things; but I think the element of vagueness in his own views and suggestions is due to the fact that not sufficient emphasis is laid upon the economic side of social problems. All socialists will agree with Mr. Branford in his distinction between money-wages and real wages—between mere pieces of metal and the things that a careful buyer may obtain in exchange for them. All socialists, too, will entirely agree with Mr. Branford that we need, not only better cities—cities beautiful, well supplied with parks, libraries, theatres, and the other blessings that civic life makes possible—but also the power of entering into these blessings and appreciating them. But what does the city beautiful, with its theatres, libraries, parks, signify to the man who has to labour from early morn to late night in order to earn sufficient to house and feed himself and his family? That is where the economic problem obtrudes itself, and demands solution before all else.

But I do not wish to seem unduly critical of a book that contains much that is interesting to read, and would, I am sure, be profitable to put into practice where profit is measured by spiritual gain. Especially welcome is Mr. Branford's plea for closer union between City and University. All the wealth of learning that the University might deliver to the City for civic betterment remains in this country, at least, undelivered and unused, because of the lack of union between the two. And, of course, all sociologists, of whatever creed, welcome Professor Geddes' system of social surveys, of whose value Mr. Branford is a warm advocate. As in man or machine, so, too, in city, we must know where the evil lies before we can profitably set about curing it. As well, also, as Mr. Chesterton has pointed out, we must know what state that is which our cure should aim at. Hence the need, not always recognised, of lofty social and civic ideals.

H. S. REDGROVE.

WAVES.

Waves of Sand and Snow, and the Eddies which make them.—By VAUGHAN CORNISH, D.Sc. 383 pages. 80 plates. 30 figures. 2 maps. 9-in. × 6-in.

(T. Fisher Unwin. Price 10/- net.)

Dr. Vaughan Cornish has made the subject of Waves his own, and many are the scientific papers which he has written on the subject. He has already put into readable form his researches on the waves in water, and he has now brought together his observations with regard to those on sand and snow. Dr. Cornish's work has taken him all over the world—to study the waves in the desert sands of Egypt and the ripples in snow in Canada—and it strikes us that, however interesting travel may be, it must become all the more so when there is some definite object for which this primary is undertaken.

The first sand-waves which Dr. Cornish considers are those made by the wind. Incidentally his researches have led him to explain the dust and dirt which accumulate at the foot of the wind-screen of a motor-car. It is possible to look over the top of one of these without feeling the wind in the eyes, the direct current of air being thrown slightly upward. If the hand be held close to the floor, however, a return draught can be felt which brings the rubbish already mentioned. An interesting point with regard to the taxicab is also mentioned by Dr. Cornish. When the cab is opened by letting down the back part, an inconvenience is caused by the fact that the front of the cab has not been designed as a wind-screen, and is too high for the purpose, so that the return current of air, instead of striking the back of the vehicle, cuts in over it, blowing in on the back of the passenger's head and neck. All sorts of interesting subjects are introduced, such as snow-mushrooms, which are a little away from the main point of the book. They form on the stumps of trees, which, owing to their hardness, are left to a height of six feet above the ground when the timber is cut for building snow-sheds to protect the trains from avalanches in the Selkirk Mountains west of the Rockies. The tree-stump pedestals had generally a diameter of two feet, and the snow-caps, or mushrooms, were of the nearly uniform diameter of nine feet. An illustration of one of these we have permission to reproduce, and our other picture will serve to show how finely illustrated the book is (see Figures 332 and 333 on page 338). The ridges made by sledges come in for attention, as well as the subject of Mackerel Sky. To those who are interested in the world around them, or who seek an attractive subject for study, we heartily commend this book.

W. M. W.

XUM

THE PRESENT POSITION OF THE ATOMIC HYPOTHESIS.

By GERALD HARGRAVE MARTIN, F.C.S.

PHYSICAL SCIENCE is passing through a period of revolution. Armed with the electrons, her latest and quickest projectiles, Atomics has carried the war far into the provinces of Energetics.

Not only does she claim Electricity for her own, but corpuscular theories of light and heat have been revived, and it has been suggested that time does not flow continuously, as had been supposed, but is discontinuous, and passes on, atom by atom. Sir Oliver Lodge complains that an attempt is being made " to reduce Physics to a sort of glorified Chemistry," while the great anti-atomist, Ostwald, tells us that recent discoveries have raised the atomic hypothesis to the rank of a well-grounded scientific theory.

On the other hand, we find the electrical theory of matter growing in favour, while the chemical elements of which the eternal atoms were composed have limited lives.

We learn that the law of conservation of mass is not strictly true, and the hypothesis of an aether is said to be no longer tenable. The only law of conservation which may be true is the law of the conservation of energy.

Is Atomics absorbing or being absorbed by Energetics ?

Let us glance at the evolution of the ideas of matter, atoms, and energy. All knowledge of the external world is derived, directly or indirectly, through the sense-organs, which are only affected by certain forms of energy : " They respond to energy differences between themselves and their surroundings," said Ostwald.

As Kant taught, of things in themselves we know nothing ; we only know of their existence by the effects they produce on our sense-organs ; hence all direct knowledge of the external world is confined to memories of the sensations of light, heat, touch, sound, taste, and smell.

According to Elliot Smith, smell was the predominant sense of the Ptilocercus-like ancestor of the primates, but in man sight has become the predominant sense. " Seeing is believing," hence the visualising tendency in human nature.

" All intelligent action whatever depends upon the discerning of distinctions among surrounding things," said Spencer, and, as Leibnitz pointed out, a substance is only discovered when it has been shown to differ from all known substances.

As all knowledge is relative, the primary task of practical science consists of the detection and measurement of differences, while theoretical science attempts to classify the differences observed.

Now, in order to measure, it is necessary to adopt a standard, and, moving along the lines of least resistance, man has, whenever possible, used himself as a standard.

People are still measured in feet and thumbs, or inches, and horses in hands, while our ten fingers caused 10 to become the basic number of our arithmetic.

John Locke pointed out that we derive our ideas of duration from the flow of thoughts taking place in the brain, and, according to H. Poincaré, our idea of a space of three dimensions is derived from our muscular sensations. The three axes of space meet in our body, and we carry them about with us.

The terms "hot," "cold," "hard," "soft," "moist," "dry," and so on, also all refer to the human body as standard.

" Man is the measure of all things," said Protagoras, and it is the replacement of the human body by more accurate and constant standards that converts ordinary knowledge into science.

" To find an impersonal method of measurement is to found a science," said Le Dantec.

One of the most striking facts about the human mind is its total lack of originality ; so far, nobody has succeeded in recording any really new and original idea.

New ideas can only be obtained from Nature by observation, and the fundamental ideas of science have been gradually evolved from the anthropomorphic views of primitive man ; new theories are constructed from the fragments of older ones.

Newly observed phenomena can only be explained by comparing them with previously known phenomena, and Ostwald defines an hypothesis as an attempt to explain the less known in terms of the better known.

Since the beginning of civilisation the importance of the unorganised solids to man has steadily increased.

Thus the first two periods are known as the Stone ages, which were followed by the Bronze age, and we are still living in the Iron age.

Clubs, levers, knives, spears, and so on, were the important things for primitive man : they were used to concentrate human energy, and they helped those races which best knew how to make and use them, to become the fittest to survive.

Most unorganised solids change so slowly in comparison with man that they were believed to be

unchanging, and the study of these substances led to the abstraction of the idea of eternal matter.

It was the mechanical properties of solids that especially interested man, and they also supplied science with standards and measuring instruments, so that they became the better known in terms of which the less known had to be explained.

As the only things known to primitive man which could do anything, *i.e.*, bring about any changes, were himself and the other animals, he had no option but to extend this one animal cause to explain all the changes he observed in Nature.

A man who causes many changes is said to be an energetic man, and it is from this idea of human energy that the modern conception of energy has been evolved.

At first animals, trees, stones, and so on, were endowed with human energy and caprice, to account for the changes in Nature; but during the metaphysical stages of science these views were replaced by the idea of centralised forces, and what Soddy terms "the preposterous notion that forces really exist, and are the permanent attributes of masses of matter, molecules, atoms, electricity, and so on." The experimental study of the chemical and physical energies, and their transformations, has led to the modern conception of energy.

During the metaphysical stages of science, men began to busy their minds about the constitution of substances.

Are they infinitely divisible, or is there a limit to their divisibility? To say that they are infinitely divisible does not help us to understand them, for the mind cannot grasp infinity.

Nature repeatedly suggests an explanation for the constitution of apparently homogeneous solid objects: the flock of sheep on a distant hill, the leaves on a large tree, and the grains of sand on the seashore, all appear as homogeneous solid objects when viewed from a distance. At first sight it does appear highly probable that solids consist of indivisible particles, and this was the conclusion arrived at by Kānada, Democritus, Leucippus, and other early philosophers, who had but very little science upon which to base their conclusions.

"When a theory appears probable, be sure that it is false," said Fontenelle. Now, water, the oils, and so on, were classed apart from the solids, because their mechanical properties are quite different; how are these liquids constituted? Although they were classed apart precisely because they are not solids, their constitution had to be explained in terms of the better-known solids; they were said to be composed of solid atoms, and the constitution of gases met with the same fate.

For atomics, liquids, and gases are solids.

The *raison d'être* of these ancient atoms was to explain the constitution of the apparently unchanging parts of nature, so they were said to be indestructible, indivisible, solid particles, which could form transitory aggregates

These atoms were the product of metaphysical speculations. Nothing was known about them, and they did not really overcome the difficulty of infinity; for if a particle is to be theoretically indivisible, it must be infinitely small, a mere mathematical point.

Alchemy was by its nature essentially an experimental pursuit. The alchemists found that the properties of substances can be changed in the laboratory; thus all substances are more or less affected by heat.

With the aid of the mineral acids the alchemist could transform even that most noble metal, gold, into a transparent liquid. What a wonderful transformation!

Bright liquid mercury, heated with a little yellow volatile sulphur, became transformed into an intensely black brittle mass. What an extraordinary change!

If man can bring about these astonishing changes in the laboratory, why should he not be able to alter the properties of lead, or silver, just a little, so as to make them identical with those of gold?

If he did, he would have transformed them into gold, for substances are only known by their properties.

This was quite a logical view to take, and it harmonised with the doctrine of principles, or metaphysical elements of Empedocles and Aristotle; so it put atomics in the background.

These peripatetic elements, hotness, coldness, dryness, and moistness, which were carried by one original matter, were not really four distinct principles, but only two, referring to the temperature of the body and the moistness of the skin as standards.

Owing to the materialising tendency in human nature, the metaphysical elements of the earlier alchemists became transformed into ponderable elements; thus the metaphysical mercury and sulphur of Geber became materialised into quicksilver and brimstone, and the properties of substances were attributed to their material composition.

With the revival of learning, atomics again came to the front. According to H. Poincaré, it was astronomy which first taught men that there are laws in nature, and astronomy, mechanics, and geometry were the first sciences to make any considerable progress; so they supplied the better-known, in terms of which the less-known phenomena of the more backward sciences had to be explained.

Although chemical energy is obviously a non-mechanical form of energy, chemical phenomena had to be explained in terms of the better-known mechanics.

At first it was by the falling together of like atoms that all things were made, then it was unlike atoms which united, and they developed points, cavities, little hooks, and electrical poles with which to combine.

By definition an atom is that which cannot be divided; hence, logically, it cannot have any

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parts, for if it had it could be divided into these parts.

Most chemists have been pragmatists: they judged their hypotheses according to their classificatory value, rather than by logic.

Thus the chemical properties of substances were ascribed to statical atoms, and the physical properties to dynamical atoms; nor did chemists hesitate to write about atoms of compound substances; until experiment drove them to the more logical idea of molecules.

Modern chemistry is based upon the stoichiometrical laws, but, as Ostwald observes, although science possessed the atomic hypothesis for over two thousand years, nobody deduced a single stoichiometrical law from it; such laws were discovered in the laboratory.

The modern so-called atomic weights are relative values, selected from the combining weights of the elements, and their electro-chemical equivalents, which are obviously energy constants.

The choice was determined chiefly by the specific heat of the elements, the periodic law, and the volume energy of substances in the gaseous state at normal temperature and pressure; hence these modern atomic weights are purely energetic constants, and are independent of the atomic hypotheses.

In the early days of organic chemistry, chemists had no energetic data to guide them in their choice of the atomic weights of carbon, hydrogen, nitrogen, and oxygen, so here the atomic hypothesis had to rest on its own merits.

This it did, and introduced such a hideous state of confusion that both Liebig and Dumas advised chemists to drop it altogether, and turn it out of the science.

So the chemists replaced their atomic weights by Gmelin's equivalents. While the atomic hypothesis was in disgrace, the theories of types arose, from which the modern graphic formulae have been evolved.

These formulae supply the discontinuity and immobility necessary for the formation of a clear mental image: they are designed so that as many of the properties of the substance as possible are indicated by convention.

They constitute a classification by properties; it is the properties which define the formula, and not the formula that determines the properties.

As Duhem has clearly shown, there is really no question of a mechanical constitution of compounds.

It is the human mind which demands a mechanical explanation, or mental image, and not the compound that demands a mechanical constitution.

The physicists evolved hypotheses of dynamical atoms; true, each dynamical atom was a *perpetuum mobile*, or that which cannot exist, but for atomics this was a detail.

This strange dead, fossil world of inert matter was composed of absolutely hard, absolutely elastic, absolutely indestructible, absolutely frictionless atoms, which were kept in eternal motion by mysterious centralised forces in an infinitely rarefied, frictionless, all-pervading aether, which was much more rigid than steel, and millions of times denser than lead. The duty of the aether was to overcome the difficulty of action at a distance, but in this it was unsuccessful, for its "smallest parts" had to be in a violent state of rotational motion to explain its rigidity; hence it could not be continuous itself; it had to be materialised and atomised to give a mental image.

Dynamical atomics was based on celestial mechanics, but the motions of the stars are not eternal: tidal friction acts slowly, but none the less surely, as a brake.

It was only the brevity of human life that caused the motions of celestial objects to appear to be eternal, just as it caused the chemical elements and the biological species to appear to be immutable.

If all phenomena are due to the mechanical motions of frictionless atoms, all changes, and therefore also physical time, should be reversible.

Thanks to the law of the conservation of energy, a given quantity of any measurable energy can be translated on paper into terms of little particles of mass (m), moving with velocity (v); but this is merely a matter of arbitrary units.

The atomic hypotheses reduced chemical theory to what Ostwald described as a "strange, contradictory conglomerate of the fossil constituents of all former theories," but they were so far removed from the facts that they had but little or no influence upon laboratory methods.

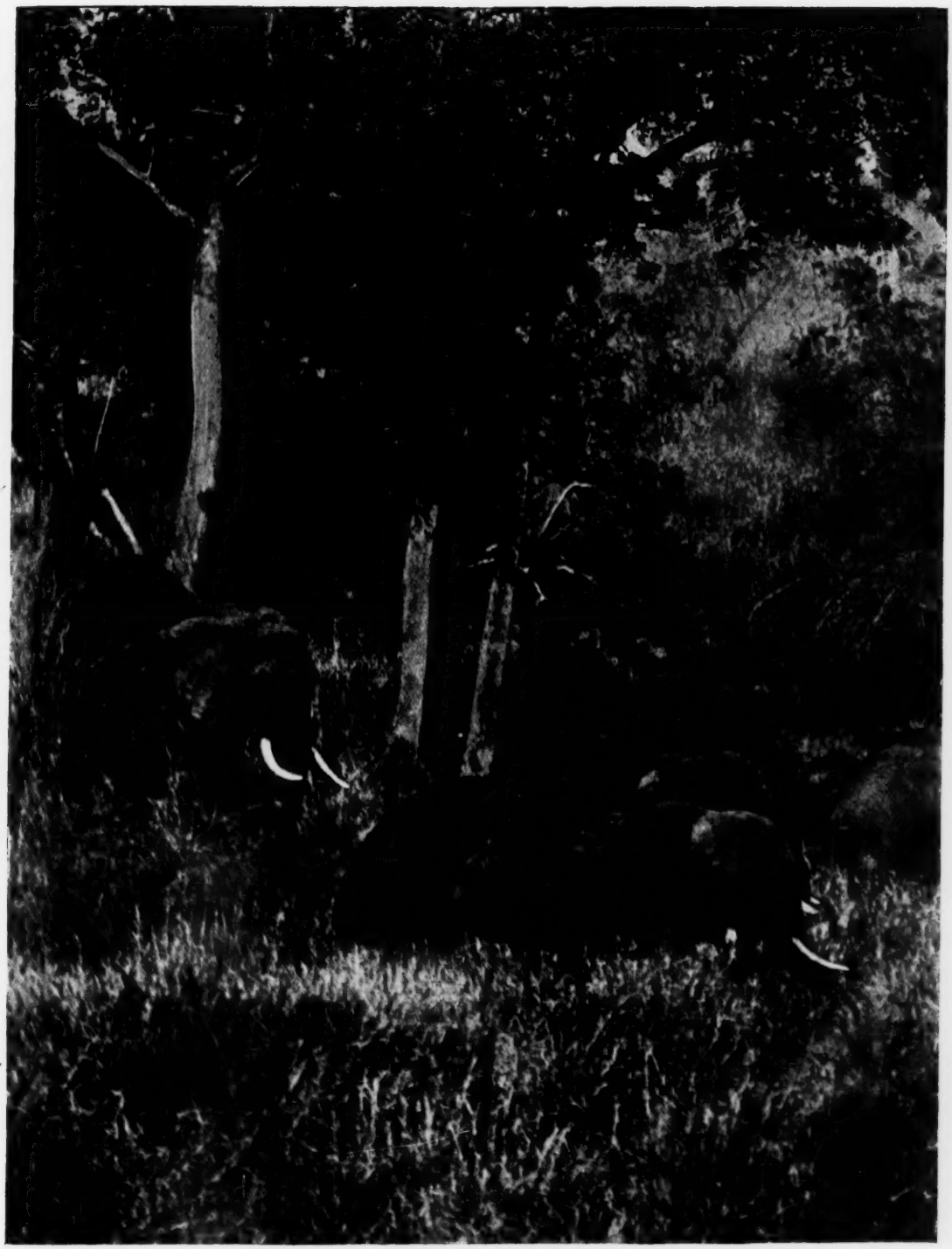
Chemistry remained an essentially inductive science, and the chemist still relies upon his chemical instinct to guide him in research.

Atomics attempted to eliminate time from chemical theory, yet it is only changes that are cognisable, and change is the author of time; hence questions of time underlie the whole of practical chemistry.

The phase rule gave chemists a practical chemistry in space, and the most crying want of modern chemistry is a chemistry in time, to bring theory into closer touch with practice.

The atomic hypothesis gave no foresight; none of the great advances in chemistry were deduced from it, but after the advances had been made, it was rather a question of bolstering it up with supplementary hypotheses, to try to give it some semblance of covering the new facts. Witness the hypotheses of electrical poles, atoms of aether, vacua in the aether, vortex rings, constant, variable, fixed, movable, bendable, positive, negative, neutral, partial, normal, contra, and constantly varying valencies, and so on. Nor can it be said that atomics explained either the physical or the chemical properties of substances.

The idea of two atoms of oxygen united to one atom of carbon no more explains why carbon dioxide is a colourless, somewhat soluble, and reäctive gas than the idea of two atoms of oxygen united to one atom of silicon explains why silica



From a photograph *by Fred Russell Roberts.*

FIGURE 334. African Elephants. In the high grass.

(From *Wild Life*. Volume IV. Number 3. By the courtesy of The Wild Life Publishing Company.)

From a photograph by Fred Russell Roberts.

FIGURE 335. The White Rhinoceros.

(From *Wild Life*. Volume IV. Number 4. By the courtesy of The Wild Life Publishing Company.)

is a hard, crystalline, difficultly fusible, inert solid.

According to atomics the properties of a compound should be the sum of the properties of its constituent atoms, but chemical changes were classed apart from physical changes, precisely because, in those reäctions which first forced themselves upon the notice of chemists, the properties of the reäcting substances became fundamentally altered. One by one, experiment has transferred all the properties of substances, from eternal matter and its atoms, to the energies.

Take, for example, such a familiar element as iron. What are the properties of iron atoms? What properties does iron possess in the solid, liquid, and gaseous states, and in all its compounds?

Even mass has passed from atomics to energetics, and modern science has reduced matter to an absolutely property-less substance, which, as Ostwald remarks, is a thing unthinkable.

But the idea of atoms has survived the matter whose constitution it was born to explain; it has survived the eternal atoms to which it gave birth; it has become ingrained in the scientific mind.

To Newton atoms were solid, massy, hard, impenetrable, indivisible portions of eternal matter.

The modern atom is not indivisible. nor is it indestructible; it is not composed of matter, but of electrons, *i.e.*, of energy; it has a limited life, is compressible, and disintegrates spontaneously.

Now, what conception could possibly be further removed from the eternal, indivisible atoms of Newton, Berzelius, and Clerk-Maxwell than this?

The word "atom" means that which cannot be cut, or divided. "A particle of matter so minute as to admit of no division," said Webster; hence a complex atom is a contradiction of terms.

We must own that atoms are dead: these energy complexes are only their ghosts; indeed, no clear mental image can be formed of an electron, for you cannot picture electricity; yet the study of this form of energy has given us a most useful, practical, and exact science. When the mental picture-book of an infant science gives way to accurate measurements, the science becomes amenable to mathematics, and begins to pass into the all-embracing science of energetics.

Perhaps the great victories which atomics has recently claimed are only word-victories after all; the ideas of energetics have replaced those of atomics, but the atomic language remains.

WILD LIFE.

MR. DOUGLAS ENGLISH, the Editor of *Wild Life*, is greatly to be congratulated on the progress of his Magazine, the variety of the subjects which it includes, and the striking character of the photographs reproduced. The July and August numbers, which are now before us, are particularly good. In the first, Mr. Fred Russell Roberts begins a series of notes on African Big Game with a consideration of the Elephant, which he illustrates with a number of remarkable pictures taken by himself with a reflex camera. One of these we are kindly permitted to reproduce on page 347. Others show quite large herds of the animals, or characteristic attitudes, such as when they are suspicious of man's presence, and with uplifted trunks are "feeling the wind for him."

The same number contains two excellent photographs of young tawny Owls, by Mr. Alfred Taylor, and an article on the Dartford Warbler, specially illustrated by Messrs. Douglas English and C. W. R. Knight. Birds are further considered in a contribution on the Pied Flycatcher; Mammals are represented by an article on the Noctule; while a specially interesting paper is concerned with the nidification of the Stickleback.

In the August issue the account of the African Elephant is concluded, and further pictures given, including a specially good one of a herd of Elephants, with young calves, which have just crossed a river. Mr. Russell Roberts goes on to deal in a similar fashion with the White Rhinoceros. Of this animal we have also been allowed to give a picture (see page 348). Two well-illustrated articles deal with Herons and their allies, while Insects come in for attention.

Both the numbers contain an editorial, illustrated notes on the Zoölogical Gardens, reviews, and correspondence.

It is a pity that, just when this successful point has been reached, the war should intervene to hinder matters: paper is scarce, and, more important, both the Editor and the Sub-Editor have military duties to perform. The difficulty of carrying on the Magazine for the time being will, however, be got over by preparing several numbers containing less matter than usual; but as it is of special merit the subscribers will no doubt be pleased, and will admire the plucky endeavour to keep *Wild Life* going.

NOTICES.

THE NATIONAL RELIEF FUND.—We have the greatest possible pleasure in calling the attention of our readers to the National Relief Fund, most happily and successfully inaugurated by H.R.H. the Prince of Wales. To very many the effects of the war will be most disastrous: those who do not feel the pinch of poverty may well express their gratitude by sending a subscription for the benefit of their less-fortunate own countrymen. A coupon appears in our advertisement pages, and this can be sent, with a contribution, to H.R.H. the Prince of Wales, Buckingham Palace, London, in an envelope, which need not be stamped.

XUM

THE ROYAL MICROSCOPICAL SOCIETY.—The meeting on October 21st will take the form of a Conversazione at King's College, Strand.

SECOND-HAND BOOKS.—We have received from Messrs. John Wheldon & Company a clearance catalogue of second-hand books, which contains many dealing with Natural History, as well as sets and series of scientific periodicals.

CLASSES IN PHOTOGRAPHY.—We are asked to announce that Mr. Edgar Senior's classes in Photography begin at the Battersea Polytechnic on Tuesday, September 29th, at 7.30 p.m., and at the South Western Polytechnic, Manresa Road, Chelsea, on Monday, September 21st, at 7.30 p.m. Full particulars as to the courses may be obtained on application to the Secretary in each case.

A NEW BOOK ON BRITISH BIRDS.—Among other interesting items in Messrs. Longmans' " List of Announcements and New Books " is a new book on British Birds, written and illustrated by Mr. Archibald Thorburn. It will consist of four volumes, with eighty plates in colour showing over four hundred species. The first volume, it is hoped, will be issued in the autumn of 1914, volumes ii and iii in 1915, and volume iv in 1916.

THE NATURALIST.—The September number of *The Naturalist* is as interesting as usual. The notes and comments and news given in short and pithy paragraphs form a particularly useful feature of the publication, and two of the important papers in the current issue are " The Early History of Filey," by T. Sheppard, and the continued notes on new and critical British species of mites belonging to the Oribatidae, by the Rev. J. E. Hull.

THE ROYAL PHOTOGRAPHIC SOCIETY'S EXHIBITION.—A feature of the fifty-ninth Annual Exhibition is a striking collection of photographs by the most eminent American workers. Men of all schools have supported the Society, and it is announced that no important departure in treatment is omitted, while the scientific and technical section is crowded. The Exhibition will be open from August 24th to October 3rd, and the Society will give sixpence out of every shilling paid for admission to the Prince of Wales's Fund.

PETROLOGICAL MICROSCOPES.—We have received from Messrs. James Swift & Son a catalogue of petrological and metallurgical microscopes, which claims to be the most comprehensive one yet issued from any source with regard to such instruments and other apparatus required in mineralogical and metallurgical laboratories. Two pages are occupied with a detailed description of Dr. A. Hutchinson's Universal Goniometer, which has never previously been put upon the market. Besides fulfilling the purposes for which it was designed, namely, the examination of small crystals and the usual crystallographic and optical determinations, the instrument lends itself readily to the exigencies of experimental work. A special pamphlet going into greater detail will be sent by Messrs. Swift gratis on request. The crystal refractometer, also described, is made for the first time outside Germany, where its construction has been attempted by only two firms. In the opinion of Dr. H. H. Thomas, of the Geological Survey, Messrs. Swift's model is better designed and more massively built than the Continental form. Other new instruments are the crystal-grinding apparatus and a large microscope for measuring and screw testing. Messrs. Swift & Son are to be congratulated on their enterprise.

REVUE PRATIQUE DE RADIUMTHÉRAPIE : RAYONNEMENTS, ÉMANATIONS, SUBSTANCES RADIOACTIVES DIVERSES ET ARCHIVES GÉNÉRALES DE THÉRAPEUTIQUE PHYSIQUE RÉUNIES.—Appearing under the editorship of Dr. Paul Giraud and Dr. Henri Coutard, in collaboration with M. Gaston Daune, of the Gif Laboratory, the scope of this journal is even wider than its title suggests. Besides containing original articles and abstracts of papers published elsewhere on the purely therapeutical side, provision is made for the inclusion of papers dealing with the results of laboratory work. We may cite, for instance, the article by Professor Wassermann upon the action of radio-active substances upon cancer in mice. We can but welcome such inclusions as tending to foster the interest of clinicians in the work of the laboratory.

Besides these general features, notice should be made of a valuable bibliographical index accompanying each volume. This contains references to original articles in the current literature dealing with practically every aspect of radium-therapy.

We regret having to record an error and an omission occurring in the first volume. The discovery of radium emanation is attributed to M. Curie, whereas it was made by Dorn in 1900. In the list of Radio-active Substances on page 38 we find no mention of gamma radiation as being emitted by them.

The *Revue* promises to be of real service to a growing number of people interested in the part that radio-active bodies may play in matters biological.

G. K.

OPTICAL GLASS AND THE WAR.—That the wonderful progress which has been made in the perfecting of optical systems has been due to the large variety of suitable glasses that have been produced by Schott & Gen, of Jena, is undeniable.

For the time being supplies of this glass are unobtainable in this country, yet the production of optical instruments must continue. Never have British makers of prism binocular glasses been so pressed for supplies, for a great portion of their material has come from Schott in the past.

We are glad to find on enquiry, however, that Chance Bros., whose reputation for optical glass is old and widely spread, have been able to supply what is needed, and that the glasses are being produced without diminution in optical effect and quality.

For microscope objectives most of the makers have a sufficiency of German glass; the amount that is used in each lens is exceedingly small; and as each fresh supply of glass may necessitate a modification of the computation, a substantial quantity is usually taken at one time. We may therefore hope that our makers will continue their usual quality of lenses, and that influences may be working which will cause the production of suitable glasses for the manufacture of objectives from British material.

The output of strictly scientific optical instruments in this country is small in comparison with that of the big Continental sources, and it is doubtful whether any commercial undertaking could profitably manufacture optical glass for this special purpose; but it seems to us that the makers of micro-objectives could quite well afford to pay a substantial addition to the usual rates for this particular material, because the small pieces that are used could not in any way add substantially to the total cost.

The house of Parra Mantois in Paris has been a source of supply of optical glass for many years in this country, and it can undoubtedly be of material assistance in the future. The glass of this house, and that of Messrs. Chance Bros., could in many instances be complementary, and enable many of the present, or equally effective, systems to be supplied.

We are not overlooking modern photographic lenses in our remarks, nor the astronomical telescope. It is true that the former have been dependent on Schott's glass, but the glass for the latter can be satisfactorily supplied in this country.

A big strain is being borne by our opticians at the present time in the recomputing of their systems for the new glasses that they are compelled to use, and the making of tools for the curves determined; but, from the information we have gleaned, it is evident that the workers who entrust themselves to them for their supplies will not be disappointed.